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THE COMMERCIAL MANAGEMENT OF ENGINEERING WORKS.

By G. Siebert. With an Editorial Introduction.

IN THE ENGINEERING MAGAZINE for November, Mr. William D. Ennis made an able argument in advocacy of the engineer's fitness for advance to the executive management of industrial enterprises. In commerce, in manufactures, in transportation, in constructive work, in military affairs, in the navy, there has been enormous and rapid progress in the use of machinery and mechanical appliances—the natural tools of the engineer. Furthermore, what Mr. Ennis termed "the almost invariable consequences of engineering training"—thoroughness, command of details, observation and the comparing of observations, appreciation of the value of continuous records, courage and ability to grapple with new conditions, faculty for organisation, the concept of the fundamental importance of efficiency—these are more and more demanded of the manager of the great undertakings which characterise modern material civilisation. With every increase in the pressure of competition—and that increase is constantly proceeding—these qualities become of yet greater necessity, and Mr. Ennis sees in the training which cultivates them the natural and logical introduction to the lines of advancement leading to chief executive control.

This is a view with which THE ENGINEERING MAGAZINE has very close sympathy; but always with the further condition set forth in the introduction to Mr. Carpenter's article on page 693 of this issue—that good executive management must comprehend not only mechani-

cal excellence of product but also practical financial prosperity of the concern under the manager's charge. Lest, therefore, we should contemplate one view so long as to lose sight of other points which must be included in any complete perspective, we gladly give space in the following pages to the complement of the argument by Mr. G. Siebert. For it is, in truth, the complement rather than the controversion of Mr. Ennis' views. The latter sees that the engineer has striking qualifications for filling successfully the post of general manager; the former, that the successful general manager of most modern enterprises must be to a large extent an engineer. The ideals both have in mind are much the same—the roads by which they reach them lead up from opposite sides; or, let us say the finished product is closely alike in both cases, but the order of the processes of manufacture varies in the systems approved by our two contributors.

To a certain extent, the matter may depend on the individual in process of training; efficiency in executive position is the product partly of processes of preparation, partly of qualities inherent in the individuality of the man. It would seem that engineering education and experience were admirably adapted to testing the economy and developing the full efficiency of the human intellectual power plant in a safe and scientific manner before it is put under load; but it is certain that the conditions of the mechanical and manufacturing world today are producing—have produced—a new need for controlling genius, and a new type of intellect and ability to fill the need. The new industrial manager is more than merchant, though he must deal with the economic and financial problems which are peculiarly the merchant's consideration—he is more than engineer in the senses heretofore received, though he must employ and adapt the work of engineers in many specialised lines. He must handle all these elements as forces in the larger applied science of production. The man is here before we have a name for him. Mr. Gunn, in our Works Management Number in January, 1901, suggested the title of production engineer or commercial engineer. According as one regards the commercial or mechanical side of the new science of organised industry, one or the other element of the preparatory training seems more important. Let Mr. Siebert present the argument for the commercial manager. THE EDITORS.

IF it be a fact that the vast progress of the last half-century is the result of taking the executive management of industrial enterprises out of the hands of merchants and giving it to engineers,

it may perhaps be idle to seek for any other answer to the question of the relative fitness of these two classes of men for this work than that given by Mr. William D. Ennis in the November number of THE ENGINEERING MAGAZINE.

It is there contended that the engineer has proved his fitness for executive leadership, and that his technical training gives him a natural claim to such positions. While the educational value of the engineer's practical training cannot be gainsaid, it does not necessarily follow that the members of the mercantile calling lack the abilities and qualifications essential to the successful direction of industrial works, nor that their commercial career may not be just as good a school for the development of these abilities as is an engineering course.

It is indisputable that the achievements of the engineer have had the greatest influence upon industrial growth, but even the engineer himself would, perhaps, have it recognised that this influence is due more to his technical knowledge and ability than to his executive and administrative capacity. The latter may be the case, but it is not necessarily in consequence of his engineering training. While giving the engineer full credit for his technical work, it cannot be denied that the business man has had a large share in making this work of practical value. It has often happened that engineers of undoubted professional ability, when entrusted with the direction of industrial enterprises for developing their own inventions, have been denied that commercial success which was afterwards achieved by the practical business man who took over the management.

If it be really true that the administration of industrial enterprises is now largely in the hands of technical men—which assumption may be found, on closer investigation, to be only partially substantiated—this state of affairs may be a grave danger in times of commercial depression. The engineer and the business man belong to two distinct callings, which, essentially, have really nothing in common. One creates, and represents the progressive tendency; the other conserves, and is the supporting and regulating element. Both are equally important for the prosperity of an industrial undertaking, which can be assured of success only when each recognises the value of the other in the general organisation. The leading business man must therefore be properly co-ordinated with the chief technical official, and at the same time there must be some one in authority over both, with whom rests the final decision in all vital questions.

If the business man exercises functions equally important with those of the engineer, it is but proper that the way to the supreme con-

trol should be open to both. The circumstance that the engineer has had a college education does not give him a greater claim to the manager's position, for his training, while sometimes a broad general technical one, may be only one-sided and highly specialised. The young commercial man, if he desires to be abreast of the times—and it is, of course, only such that are here considered—will prepare himself for his calling not only by office work, but also by a course at a modern business college where he will get a theoretical training in administrative problems, finance, economics, commercial law, and statistics in relation to trade in general as well as to a special industry.

The time is past when the commercial man was merely a creature of circumstance, moulded by his accidental surroundings. Today, if he would obtain success, he must be educated or must educate himself, as carefully as the young engineer. Above all, if he wishes to make his mark in industrial life, and does not care to trust to mere chance, he must have a professional training which is not inferior to that of the technical man. His information, aside from the mechanical part of his calling, will not only embrace a thorough understanding of the tendencies of his own land and foreign countries, but he will become an *industrial merchant*—by which name we may distinguish him from the ordinary business man—and as such will devote himself to one branch of industry, in which he will gain at least so much knowledge of the technical processes and the properties of the products as will enable him to discuss them intelligently.

The number of business men who have reached their goal by this rapid path is still small, for not everyone is in a position to choose freely a definite branch of industry, and then to take time for practical work in shops (where the technical student undergoes a long and thorough training), and to attend lectures on the fundamentals of the chosen industry and related ones, and so to acquire most quickly and in the best way that knowledge which is necessary in order to reach the highest positions. Most of these strenuous, far-sighted young business men must acquire this information in a more toilsome way, by keeping their eyes wide open whenever they pass through a shop, by asking questions, and by reading about what they see. That such men are found, whose labours in the interest of their business are fortunately appreciated, will be admitted by every engineer who has had experience of the great loss sustained by an enterprise through the death of a managing director, who, though originally a commercial man, was the soul of the establishment. In this case experience has developed the man of purely commercial training into the in-

dustrial merchant. The latter does not and should not have any ambition to take the place of his chief technical officer, or to bother with the details of a machine or with any other purely technical matters; but he is competent to decide all questions which touch the vital parts of the industry, even though they incline toward the technical or technico-administrative side.

While the industrial merchant who rises to the manager's place does not necessarily step outside the circle of his calling, but merely enlarges it, the engineer in a similar position has, in most cases, been drawn away from his profession, to which he was originally led by natural inclination, as is stated by Mr. William D. Ennis: "The chief engineer of a large manufacturing company often becomes as little of an engineer (excepting in his methods) as his typewriter."

In order to fill the position of manager properly there is required, besides knowledge, experience and certain personal qualities. The former consists of professional experience and experience of life. The members of no calling have any peculiar advantage in acquiring general worldly experience, in profiting by it, and in making practical application thereof. Whether the prosperity of an industrial enterprise is more enhanced if the manager has acquired his professional experience as an engineer or as a merchant, is a matter of individuality and depends upon each special case. If the commercial and technical authorities, as is most advantageous, work hand-in-hand, the professional experience of both will be available, and the fruit of such experience is shown principally by a rational economy.

The first aim of a business man is to establish the principles of economy and act in accordance therewith, and it is commercial considerations which prompt an engineer to shape his practice efficiently. His profession in itself is less apt to hold him thereto.

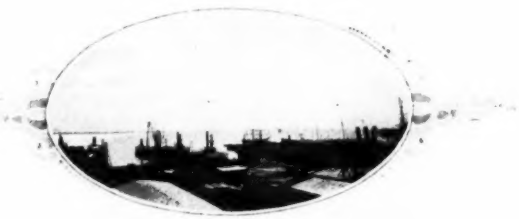
Statistical and graphical charts are an aid in the use of which the modern business man is just as expert and intelligent as is the engineer. It is true that the manager who has come from the commercial ranks first learns from these records that there is a lack of efficiency and how to remedy the defect, while the technical director may be able sooner to detect the trouble and abolish it. However, it is the duty of the superintendent to recognise any faults in time, and he can be held responsible. In general, the manager, be he originally a technical or a commercial man, can consider his part done when he has perfected an organisation which permits nothing of importance to escape his final control.

Among the qualities which should be possessed by the director of

an industrial establishment may be mentioned: Integrity of character, organising talent, a high sense of duty, practical views joined to energetic ways, and a love of justice. These attributes are born with a man, though they may later be modified by environment. Some may be promoted by engineering training, others by commercial life; but no calling determines them completely.

There is therefore no doubt that the industrial merchant is as well equipped for the post of manager as is the engineer. If, in a particular case, one of them is to be preferred, this will naturally be determined by the given circumstances. When such a place is to be filled, however, it should be a fixed rule to consider the members of both engineering and commercial staffs. While engineers are at present successfully occupying such positions, similar results were formerly achieved by managers who rose from the commercial ranks, and many modern instances of the latter kind might be cited.

It may be that there is a lack in industrial life of broadly cultivated commercial officials who are something more than good bookkeepers, accountants, and secretaries—that is, who possess the necessary qualifications for the highest careers in industrial enterprises. But this would show only that there are not enough successors to the old commercial managers to supply the demand, or that their growth has not been sufficiently encouraged. And this, again, may be in consequence of the fact that the wide limits of the field for the commercial man within the great industrial consolidations is not generally enough recognised; that people with an ancient prejudice against the "theoretical" (that is, academically educated) merchant, do not give him an opportunity for that wider development, which is absolutely necessary for him in this rapidly moving era, in order that he may quickly meet the growing demand made upon him to extend his knowledge over industrial matters, and to specialise therein, without renouncing that universal culture which keeps the mercantile calling open to him.



PRACTICAL APPLICATIONS OF REINFORCED CONCRETE.

By Jacques Boyer.

In Professor Boyer's first paper the various systems of reinforcing concrete by imbedded metallic constructions were described in detail, and the methods of erection discussed. After considering the construction of pipes and reservoirs the materials for various branches of work are treated in the present article, together with an account of tests which have been made upon arches and similar structures, followed by descriptions of important works which have been executed in reinforced concrete in various parts of the world.—THE EDITORS.

Casino of St. Enghien, Cottancin System.

GENERALLY speaking, the various systems of pipe construction in reinforced concrete include metallic reinforcements composed of circles or spirals to provide circumferential strength, together with longitudinal rods following the direction of the generatrices, the whole being entirely imbedded in concrete or cement. If the pipes are of moderate diameter they may be constructed in wooden moulds as usual, and connected by suitable sleeves when laid; but large sections may be made in place.

Pipes of this sort at first are not satisfactory, since there is a seepage of water due to the porosity, this porosity, according to M. Gérard Lavergne, ranging from 13 to 33 per cent. of the volume for concrete composed of 250 to 550 kilogrammes of cement per cubic metre of sand. This defect gradually disappears as the calcareous portions unite with the carbonic acid to form an insoluble carbonate of lime, which closes the pores. As a typical example we shall describe the Bonna system, which has been extensively used.

The skeleton of the pipes is very simple, consisting of hoops or rings of iron or steel, within which are placed longitudinal bars. (Figure 2.) The network thus formed is then imbedded in concrete of varying thickness. The dimensions of the reinforcements must necessarily be determined by the intended service.

FIG. I. REINFORCED-CONCRETE RESERVOIR, COTTANCIN SYSTEM.

When piping is intended for the distribution of water or gas, M. Bonna has devised a different construction. (Figure 3.) This style, like the preceding, consists of hoops and bars of steel imbedded in concrete, but also contains an internal tube of rivetted sheet steel to provide a lining for the porous concrete. The reinforcement permits this inner tube to be quite thin, while the whole construction resists the action of oxidation in a high degree. The joints of the inner tube are made with short sleeves, packed in the same manner as in the case of ordinary cast-iron pipe. If long continuous sections of pipe are used, it is desirable to use occasional expansion joints, as shown at A. This joint is made of a simple sleeve of sheet steel, packed with rings of rubber and asbestos, these being retained in position by the concrete.

For very large water mains a double reinforcement may be employed, with a lead-lined sheet-iron pipe inside. (Figure 4.) The connecting portions are made either by means of sheet-iron sleeves

and concrete, or by light cast-iron sockets. Branch connections to pipes of this kind are readily made, as shown in Figure 5. The external concrete is removed, as well as a portion of the reinforcement, and the cast-iron branch and stop-cock is attached by means of the ring bolts. The joint with the exterior of the pipe is made with a washer of leather, and the interior lead-lined pipe is finally cut through with a chisel.

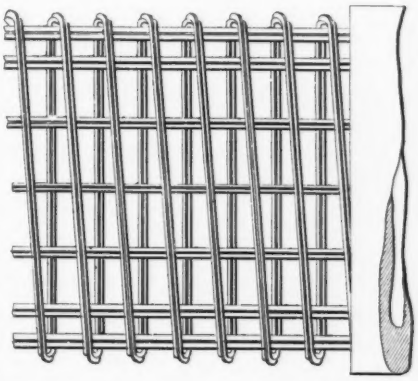


FIG. 2. REINFORCEMENT FOR ORDINARY PIPE, BONNA SYSTEM.

In view of the extensive use which has been made of reinforced concrete pipes in connection with important works of the water service of the city of Paris, this form of construction may be said to have received the sanction of good modern practice. (Figure 6, page 663.)

The conditions under which these were used have brought out some of the principal advantages of the method. Their strength, tightness under pressure, and convenience, have made them acceptable for a great variety of services, including water, gas, drainage,

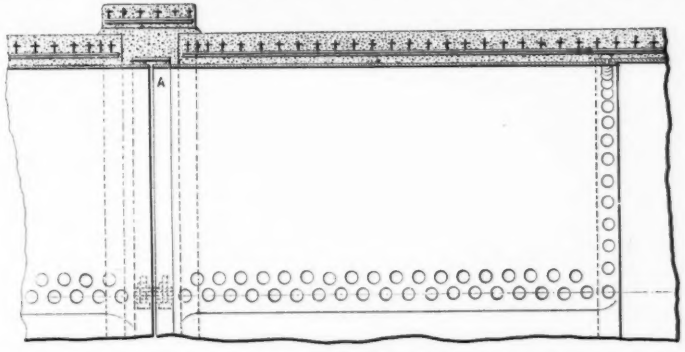


FIG. 3. LONGITUDINAL SECTION OF REINFORCED-CONCRETE PIPE WITH RIVETTED SHEET-STEEL LINING TUBE FOR HIGH PRESSURES. BONNA SYSTEM. THE JOINT IS AT A.

etc. Who knows but that pipes of this construction may ultimately be employed for the pipe-lines of the American petroleum districts?

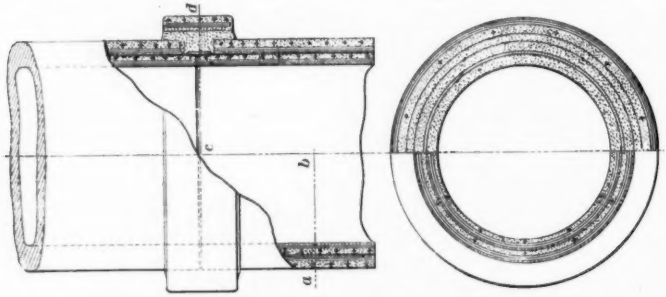


FIG. 4. CONCRETE PIPE WITH DOUBLE REINFORCEMENT FOR HIGH PRESSURE, BONNA SYSTEM.

In the construction of reservoirs M. Cottancin has often adopted the rectangular form, with a spine-rib of metal about the upper part and a number of similar vertical ribs along the sides. If the supports of the structure are in a circle, the reinforcing ribs are placed in three series parallel to the sides of an equilateral triangle inscribed in the circle. On page 660 is shown a reservoir of 300-cubic-metres capacity erected at Versailles by M. Cottancin. On the left side of this it was required to construct an opening of 8-metres span, and the base was there reinforced by metallic ribs and a notable economy effected.

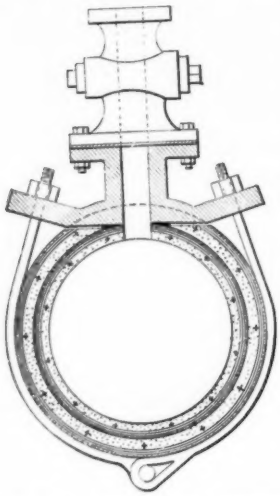


FIG. 5. CONNECTION OF STOPCOCK AND BRANCH WITH A REINFORCED-CONCRETE PIPE MAIN.

The reservoirs constructed by M. Monier are nearly always cylindrical, reinforced by circular or helicoidal rods. When these reservoirs are placed underground the bases and covers are reinforced by radial members or by cross beams forming equilateral triangles. When prismatic forms are employed the rods are inserted so as to strengthen the vertical faces. For a head of 5 metres of water the thickness of the walls at the bottom is made about 12 centimetres, diminishing to 6 centimetres at the

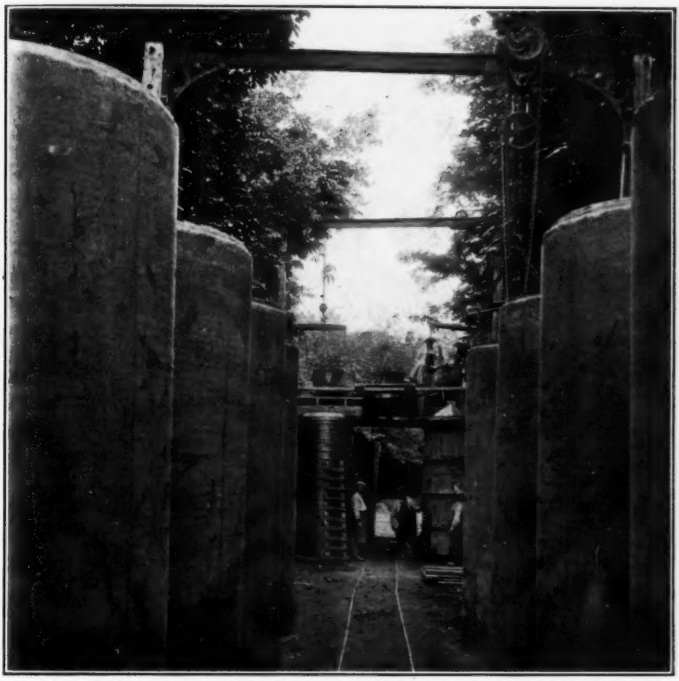
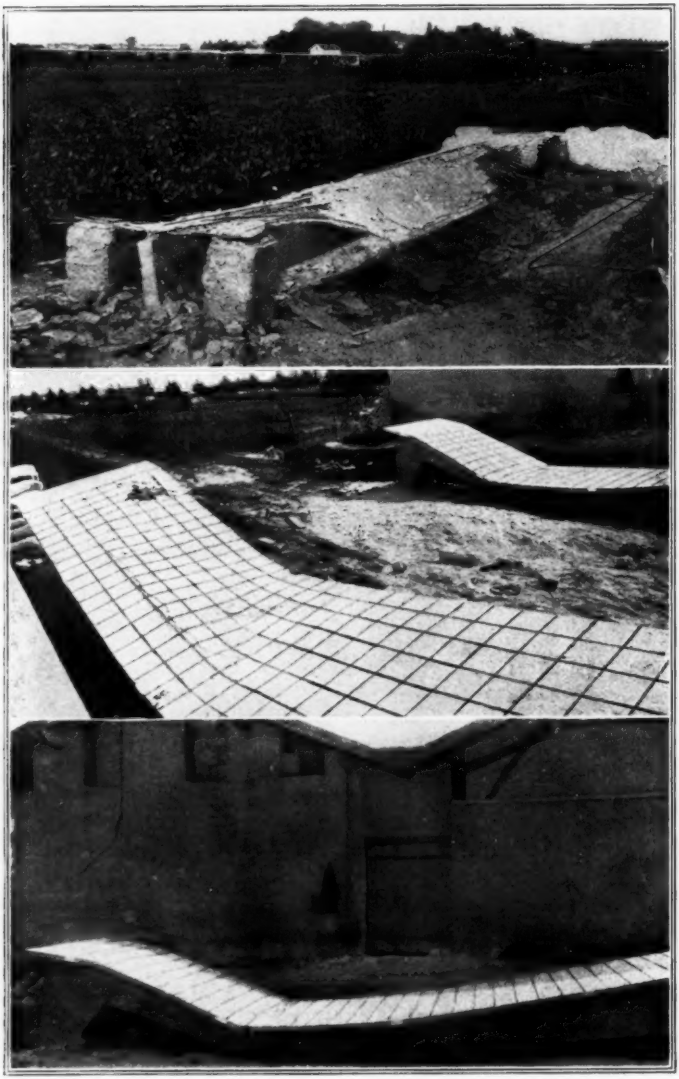


FIG. 6. FACTORY FOR MOULDING PIPES OF REINFORCED CONCRETE, BONNA SYSTEM.

top. In selecting materials for use in works in reinforced concrete, engineers are almost unanimous in their preference for Portland cement. Although the more rapid-setting cements show a higher resistance in a few days, this advantage is soon lost, besides which the composition of the cement is not so homogeneous. The same is true of slag cements, which dry too rapidly, forming thin layers. The composition of the concrete naturally varies with the nature of the work, and some actual data will serve to illustrate.

A concrete consisting of 300 kilogrammes of cement per cubic metre of sand has at the end of six months a compressive resistance of 200 kilogrammes per square centimetre, (2,845 pounds per square inch), while if 600 kilogrammes of cement are used per cubic metre of sand, the resistance is increased to 500 kilogrammes per square centimetre (7,112 pounds per square inch); so that the greater expenditure of cement permits a material reduction in the thickness of walls, partitions, and similar works. In this, as in all similar cases,



FIGS. 7, 8, AND 9. THE TOP VIEW IS THE RESULT OF THE DESTRUCTION OF AN ARCH (NO. 1 SYSTEM, PAGE 666) UNDER A LOAD OF 10,000 KILOGRAMMES; THE MIDDLE VIEW IS A NO. 2. SYSTEM ARCH DESTROYED BY A LOAD OF 12,000 KILOGRAMMES; THE BOTTOM VIEW IS A NO. 3 (COTTANCIN) SYSTEM ARCH CRUSHED BY A LOAD OF 20,000 KILOGRAMMES.

it is necessary to exercise judgment and not to diminish the thickness too far. For ceilings of 10 centimetres in thickness a proportion of 300 kilogrammes of cement per cubic metre of sand appears to be the best. For floors and arches, from 400 to 500 kilogrammes of cement may to advantage be employed to the same proportion of sand, while for light beams or similar work not subject to much loading, and not required to be absolutely water-tight, the proportion of cement may be reduced to 250 kilogrammes per cubic metre of sand. In making heavy slabs, in which strength rather than tightness is demanded, a concrete is made with four parts of gravel or broken stone to one of sand, instead of using sand alone with the cement. When resistance to the pressure of water is required, a mixture of two volumes of cement to three of sand is recommended, or even equal parts of both.

In preparing a reinforced concrete, the sand should be fine and sharp, with angular particles, this being especially important in making pipes and conduits; and, in general, a siliceous sand is to be preferred to a calcareous one. So far as the metal is concerned, both iron and steel are used, according to circumstances. M. Hennebique uses wrought iron for floors and similar horizontal structures, but for walls and vertical work he prefers steel. MM. Coignet and de Tedesco use mild steel, both because of its homogeneous structure and because of its superior strength over wrought iron. The small difference in price has led engineers generally to employ mild steel.

So far as section is concerned, round rod has been much used, and its advantages are thus set forth by M. Gérard Lavergne: It is the cheapest, it occupies the smallest space in ceiling or floor construction, and the concrete is more readily able to fill the interstices in a structure of round rods than in one composed of less simple section. According to M. de Tedesco, however, these advantages disappear in comparison with the practical conveniences offered by rolled sections, arising from the facility with which they can be assembled and secured to each other, and the manner in which a self-sustaining structure can be erected before the filling of concrete is applied.

Tests Upon Structures in Reinforced Concrete:—We will now proceed to examine actual tests which have been made upon various kinds of structures in reinforced concrete, and in order that there may be no question as to partiality we shall refer to the official records. Consider, therefore, the tests made under actual loads, in France, by order of the Minister of War. The following results have been furnished to us by the Technical Commission of the Department of Engineers. In order that the data and results might be comparable,

each structure contained the same quantity of metal, cement, and sand, the specimens being divided into three groups according to the various systems:

1:—Systems in which the reinforced rib contained metallic stirrups, connecting the iron bar with the surface of the concrete.

2:—Systems in which small metallic elements were united to lattice-work at the surfaces and stirrups in the ribs, connecting the lower elements to those of the main plate.

FIG. 10. VILLA BUILT IN REINFORCED CONCRETE, COTTANCIN SYSTEM.

3:—Systems containing wire netting both in the main plate and in the ribs.

Fig. 7 represents a photograph of a specimen of construction of the first class tested to destruction by a load of 10,000 kilogrammes. The nearer example in Fig. 8 shows the manner of rupture of a construction of the second class, under a load of 12,000 kilogrammes, and the breaks show that the materials do not exert their resistance entirely in accordance with the theory. The more distant specimen in the same illustration shows a structure on the Cottancin system, this being shown more fully in Fig. 9. This latter illustration is especially interesting as showing the successful behaviour of the materials. The rup-

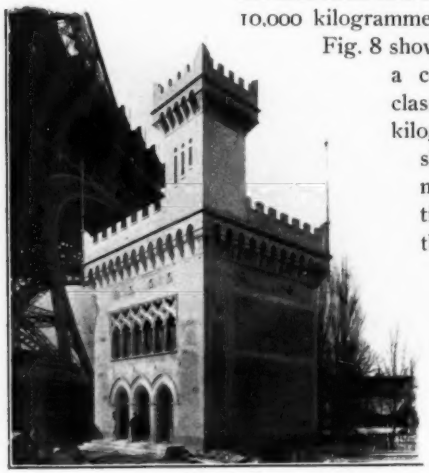


FIG. 11. PAVILION OF THE REPUBLIC OF SAN MARINO, EXPOSITION OF 1900.
Cottancin system.

ture required a load of 20,000 kilogrammes, and took place only after this load had been applied for 45 minutes. The concrete alone was ruptured and the cracks show that the compression and extension forces were resisted to an extent involving nearly the maximum amount of work, much in the same manner as if the beams had been entirely built in to supporting piers. Similar tests have been made upon the Monier and Hennebique systems, with satisfactory results.

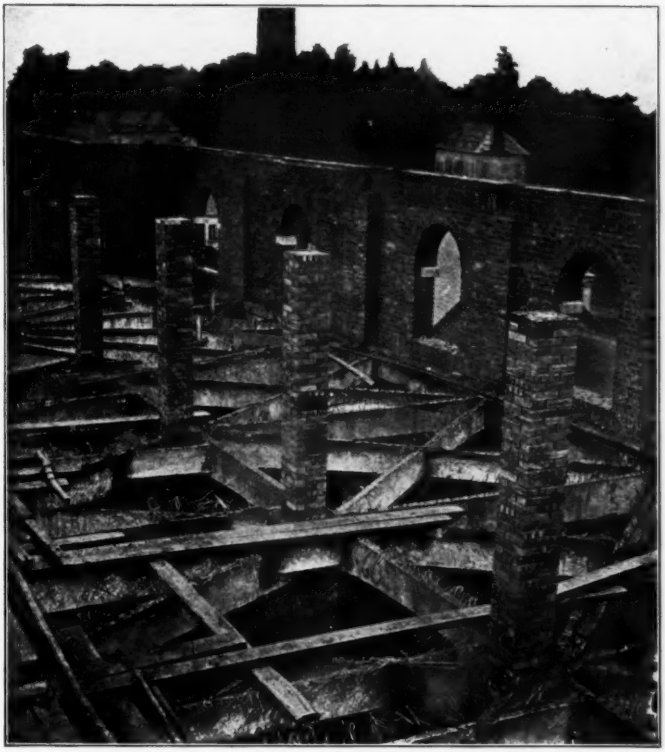


FIG. 12. FLOOR OF A FACTORY, COTTANCIN SYSTEM.

Important Structures which have been Erected in Reinforced Concrete:—We shall now proceed to illustrate a number of structures which have been erected in the various systems, showing its capabilities both for the architect and the engineer. Fig. 10 shows a villa built at Cernay (Seine et Oise) by M. Cottancin. This is a pretty residence with walls of reinforced brickwork, rough-cast on the out-

side, with wooden panelling, the whole being in the style of an Alsatian chalêt. The floors and interior framing are in reinforced concrete. Fig. 12 shows the details of the method adopted by M. Cottancin for the floors of a workshop erected at La Fère. This is constructed with the reinforced ribs already described, the floor being of reinforced concrete, 5 centimetres in thickness, and capable of sustaining a load of 5,000 kilogrammes per square metre. The piers supporting the floors are of reinforced brickwork, and the building is four stories in height. Another example of workshop construction, executed for M. Schweitzer at Paris by M. Cottancin, is shown in Fig. 13, and is interesting as indicating the manner in which structural difficulties may be overcome. The floor carries a load of 1,000 kilogrammes per square metre, and is supported by piers of reinforced brickwork, 22 by 44 centimetres in cross section. In the illustration the workmen are seen placing the network in position and wiring it to the reinforcing rods of the main ribs, so that the whole forms a complete and continuous skeleton. The construction thus affords a maximum of re-

FIG. 13. FLOOR OF THE SCHWEITZER FACTORY, PARIS, COTTANCIN SYSTEM OF CONSTRUCTION.

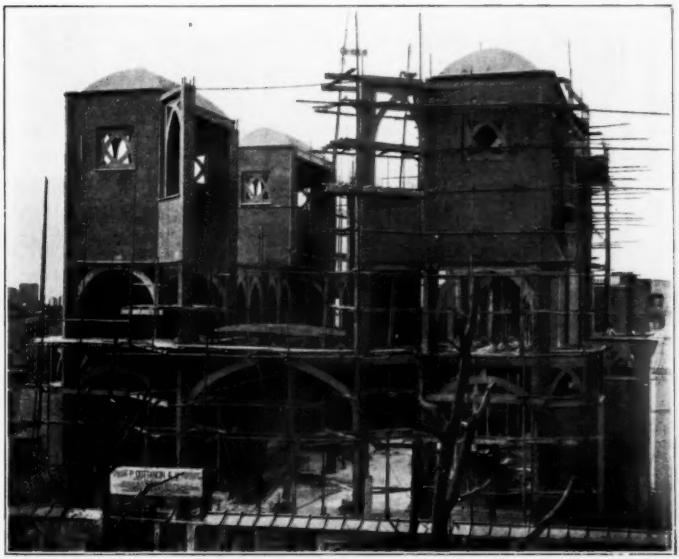


FIG. 14. CHURCH OF ST. JEAN, IN PARIS, BUILT AFTER THE COTTANCIN SYSTEM.
Showing the lightness of the scaffolding employed.

sistance with the use of a minimum of metal. The openings, required by the machinery of the biscuit bakery, are formed by bending the wires back in a manner similar to the formation of a button hole in a woven fabric, this strengthening the structure rather than weakening it, because of the ribs formed about the holes.

Another and different example of reinforced concrete is seen in the pavilion of the Republic of San Marino, (page 666), which stood close to the foot of the Eiffel tower at the exposition of 1900. This was the most economical construction at the exposition, costing but 6 francs per cubic metre, while the minimum cost of the main exposition buildings was 70 francs per cubic metre. The foundations were in the form of an inverted box, resting on the unreliable soil of the Champ-de-Mars, and were composed of reinforced brickwork and blocks of concrete. The walls were 6 centimetres in thickness, without buttresses, and these supported four arches in reinforced concrete which formed the skeleton of the cupola, and which were connected to the battlemented roof, also formed of reinforced concrete, there being skylight openings constructed with reinforced brickwork.

Another remarkable work of this kind is found in the pretty Casino d'Enghien (shown in the initial cut, page 659). This building is erect-

ed upon a platform, which is itself supported upon a caisson made of reinforced brickwork filled with earth, this forming a non-deformable base resting upon the soft ground by the border of the lake. The walls are 7 centimetres in thickness, of reinforced brickwork, roughcast in imitation of stone. The dome is made of brick and concrete, with imitation tiles, the whole being treated in a very artistic manner.

FIG. 15. WORKSHOPS OF SAUTTER-HARLÉ & CO., PARIS, CONSTRUCTED OF REINFORCED CONCRETE ON THE BONNA SYSTEM.

A structure of an altogether different character is found in the church of Saint Jean, in the Montmartre quarter of Paris. The general lines of its construction are shown in Fig. 14. This is an example of ecclesiastical architecture characterised by boldness and economy. The height of the building is 35 metres, and the walls are but 11 centimetres in thickness, the piers being 44 centimetres square. The towers are constructed of reinforced brickwork, with concrete

ribbed reinforcements, the space being filled with slag, to form a centering for the outer dome.

The preceding structures are all constructed by M. Cottancin; we now pass to some of the works of M. Bonna. These consist mainly of industrial establishments, and as a typical example we may select the new works constructed for MM. Sautter, Harlé & Cie, Fig. 15 showing the principal bay of the building, the total area covered being about 2,000 square metres. The main bay is 7.20 metres wide and the side galleries 5.45 metres. The outer walls, as well as the pillars supporting the galleries and roof-span, rest directly upon the main floor. In addition the columns support the runway for two travelling cranes, one of which weighs 27,000 kilogrammes. In spite of the difficulties encountered in this structure, a material economy was effected by the use of the Bonna system. M. Bonna has executed a number of other works, among which we may mention a building on the Avenue de la République, in Paris, built entirely of reinforced concrete from cellar to roof; also a shop for the Compagnie des Emeris, of which the skeleton is shown in Fig. 16. He has also constructed the distillery at Conflans-Saint-Honorine, as well as reservoirs for the naval arsenal at Toulon and many other works.

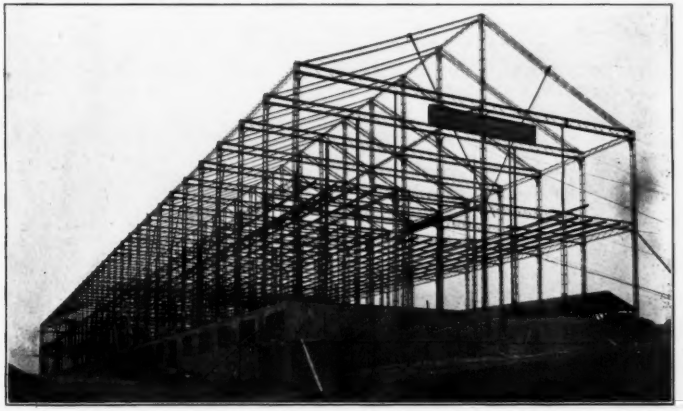


FIG. 16. FACTORY OF THE COMPAGNIE DES EMERIS, BONNA SYSTEM OF REINFORCED-CONCRETE CONSTRUCTION.

The Hennebique system was most creditably represented at the exposition of 1900. The Palais du Costume, the Pavilion of the Colonial Ministry, and of the Colonial Press, among others, were entirely constructed on that system. In the case of the Palais des Lettres, Sciences, et Arts, M. Hennebique constructed the foundations, pillars,

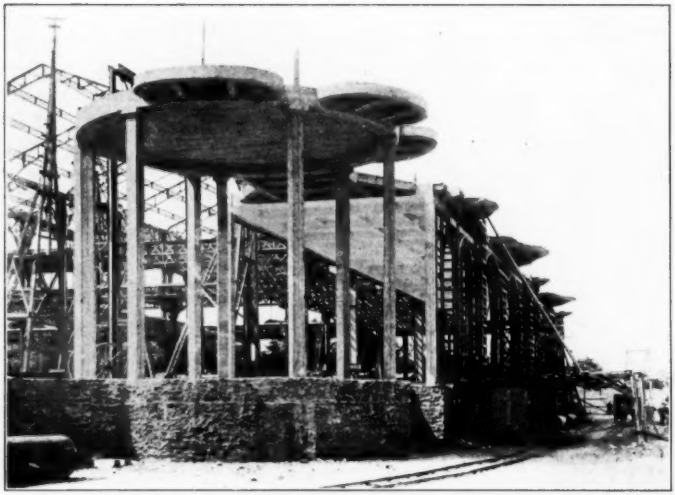


FIG. 17. FOUNDATIONS, COLUMNS, AND CORBELLED FLOORS OF THE PALACE OF SCIENCE, LETTERS AND ARTS, EXPOSITION OF 1900. HENNEBIQUE SYSTEM.

FIG. 18. HENNEBIQUE REINFORCED-CONCRETE FLUME, FOR HYDRAULIC POWER USED IN CUTTING THE SIMPLON TUNNEL.

and corbelling for the outside galleries, Fig 17. The structures have been demolished since the close of the exposition. The Hennebique system has been extensively introduced in other countries than France. At Nice, in the Hotel du Parc Imperial, there are 15,000 square metres of flooring. In Paris the new Cour des Comptes has not only the

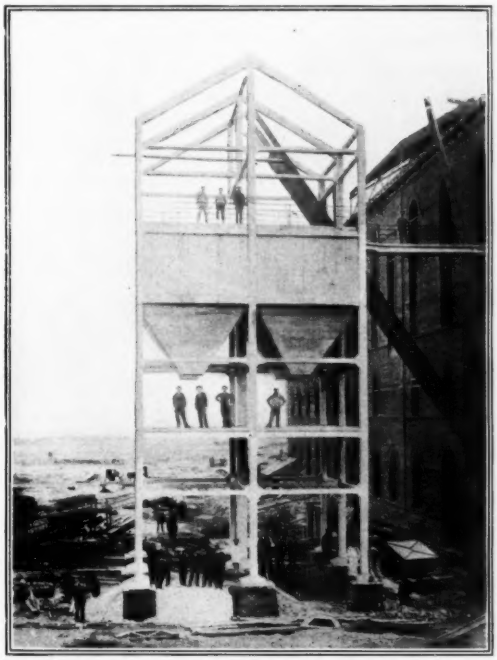


FIG. 19. COKE-STORAGE POCKETS IN REINFORCED-CONCRETE CONSTRUCTION AT ANICHE, NORD.

floors, partitions, etc., made on this system, but also the vaults for the reception of the archives.

Among industrial buildings constructed on the Hennebique system, may be mentioned the large mills at Brest (Finistère) page 678, constructed entirely in reinforced concrete, and resting on very bad ground; also the coal bins at Aniche (Nord), these being 8.40 metres above the ground and connected to the main building by a bridge of 7-metre span. At Genoa (Italy) M. Hennebique has constructed a tasteful market building. A very notable example of this system is found in the case of some lime kilns at Luzech (Lot). These have withstood continuously a temperature of 1,200° C. for two years and have

required only the most trifling repairs. Another most interesting structure is the flume conveying water to the works on the Simplon tunnel. This is shown in Fig. 18, and is an excellent example of the manner in which reinforced concrete is available in localities where the timber construction would be excessive in cost. This structure is carried along the mountain side upon piers of reinforced concrete, the total length of the flume being 3,200 metres, or about two miles.

Turning now to the subject of bridges, we shall group these also according to their respective constructors. Thus we may mention the bridge constructed in 1899 by M. Bonna, at Auch, across the Gers. This consists of four arches, the total distance being 21 metres. The width is 6 metres, of which 4.50 is for roadway and 0.75 metre for footway on each side, these sidewalks overhanging the structure on each side. The roadway is covered with a wooden paving laid directly upon the concrete flooring which extends across the arches. The arch rings are pierced with openings at the springings in order to make

FIG. 20. STRAIGHT BRIDGE BUILT ON THE BONNA SYSTEM.

the structure as light as possible, while the thrust is taken by a slab of reinforced concrete 0.13 metre in thickness, slightly inclined in order to present a face normal to the thrust. There are therefore no abutments, properly so-called, these being replaced by an extension of the arches themselves, an entirely novel construction. The reinforcements are symmetrically arranged, and were supported during the erection by bars of flat iron. Tests made by the application of heavy loads upon the completed bridge were remarkable in that they showed

no appreciable deflection. The cost of the structure was materially less than that of a metal bridge, and the expense of maintenance much smaller. M. Bonna has also constructed a number of flat bridges of moderate dimensions and of original design, of which an example is given in Fig. 20. This is practically a single thick beam of concrete, containing a number of light metal girders.

A remarkable bridge has been erected by M. Hennebique across the Vienne at Châtellerault, Fig. 21. This is composed of three segmental arches in reinforced concrete, one of 50-metres span and 4.50-metres rise, the other two each of 40-metres span and 4-metres rise. The platform of the bridge is carried by vertical pillars resting upon the arches and spaced 2 metres distant from one another, the pillars and platform both being also of reinforced concrete. The sidewalks are 1.05 metres in width, overhanging the main arches.

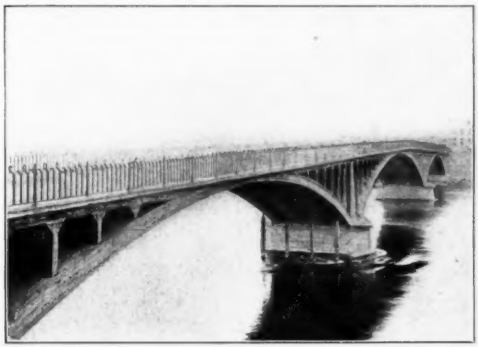
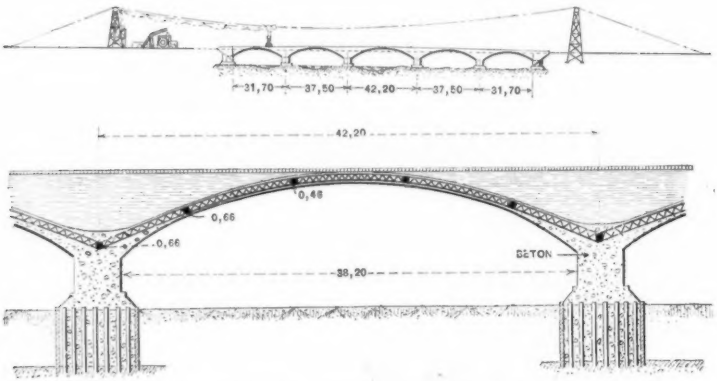


FIG. 21. BRIDGE OF CHATELLERAULT, HENNEBIQUE REINFORCED-CONCRETE CONSTRUCTION.

In Germany, bridges on the Monier system have been in use for some time, both for highways and for railways. This system is the only one patented in the empire, and up to the present time, all attempts to introduce other methods have been ineffective.

The system of the Austrian engineer Melan has been successfully introduced into the United States for bridge construction. This method differs materially from the others, requiring the use of I beams entirely imbedded in concrete. In this way the reinforcement is concentrated into a comparatively small number of members, forming a longitudinal structure of metal having in itself a considerable degree of resistance. The American concessionaries of the Melan patents have gone still further with the idea, and use the metallic structure to reinforce bridges of masonry as well as those of concrete.



FIGS. 22, 23. THE TOPEKA BRIDGE. GENERAL LONGITUDINAL VIEW, SHOWING THE CABLE AND TRAVELER USED IN CONSTRUCTION, AND SECTION OF THE CENTRAL ARCH. DIMENSIONS ARE IN METRES.

An example of Melan construction is given in the bridge across the Kaw river at Topeka, Kansas. This bridge is intended for tramways, vehicles, and foot passengers, and has one span of 42.20 metres, two of 37.50 metres, and two of 31.70 metres. Figs. 22-23. The rise is about one-fifth of the span, and the width is about 12 metres. The thickness of the arch ring is 50 metres at the key and 2.50 metres at the springings, and imbedded in the concrete are the arched lattice girders forming the reinforcement. These are constructed of angle bars 75 by 75 millimetres, and top and bottom chord 200 millimetres wide. The lattice girders are 46 centimetres deep at the crown and 66 centimetres at the springings; the side walls are of concrete, varying in thickness according to the depth from the roadway. The spandrels are filled with earth covered with concrete to form a foundation for the road. In order to provide for the handling of the material, about 20,000 tons, an overhead cableway was employed, with steam operating plant. The total cost of this bridge was $144,000, including the approaches.

General Considerations Concerning Reinforced Concrete:—The new systems of reinforced concrete appear to have been received with favour in various parts of the world. Especially is this construction indicated for workshops, stores, school-houses, and similar buildings in which protection from fire is desired.

Because of the practical identity of the coefficients of expansion of steel and concrete, the adhesion is not affected by variations in temper-

ature. According to Durand-Claye the coefficient for concrete is 0.0000135, and for iron 0.0000130 to 0.0000148.

The use of a malleable reinforcement permits the greatest facility in the construction of the most complicated forms required by the architect. Furthermore, the intimate connections which can be made between the walls, roof, partitions, and floors of a building enable a great solidity to be assured, while at the same time the various parts may be made much lighter than would otherwise be possible. Thus, according to M. Gérard Lavergne, a partition of ordinary bricks on edge weighs 100 kilogrammes per square metre, while one of reinforced concrete, 3 centimetres in thickness, containing rods 5 millimetres diameter, is stronger and weighs but 70 kilogrammes. The rapidity of execution is also an important point in favour of the concrete construction, especially since the materials are so readily obtained and heavy hoisting machinery is not required.

The methods of reinforced concrete construction are especially well adapted for underground work, particularly in humid localities such as cellars, in which external infiltrations are to be expected. In such instances it is necessary only to protect the work with a light outer wall of reinforced concrete. The iron being entirely protected from the moisture there is no danger of loss from oxidation. Even if the iron is partially rusted when it is imbedded in the concrete, a subsequent examination shows that the metal has become cleansed and has recovered

FIG. 24. REINFORCED-CONCRETE BRIDGE OVER THE KAW RIVER, TOPEKA, KANSAS.

its original color. This is doubtless caused by a chemical action, due to the formation of a double silicate around the metal.

The theories involved in the use of reinforced concrete may be briefly sketched as follows:

According to M. Planat, the most rational examination divides the practical cases into three classes. If the load is light, the concrete

FIG. 25. THE GREAT BREST MILLS, FINISTÈRE. BUILT ON THE HENNEBIQUE SYSTEM.

and the metal remain adhering to each other, subjected to a common deformation. For a moderately heavy load the metallic portions act as tension members, built into the supports at the extremities. When the load becomes excessively large the metallic portions act as suspended cables beneath the structure. From these considerations formulas have been deduced for beams and floors.

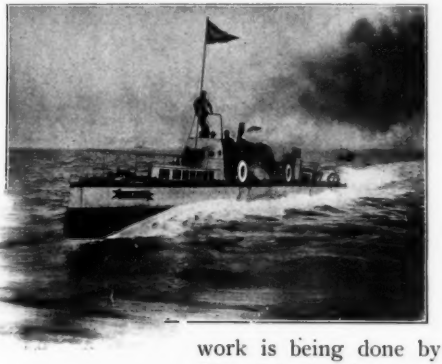
As for cylindrical structures, such as pipes and reservoirs, it has become customary to neglect the resistance of the concrete as a whole, and to regard it simply as a means of conveying the pressure to the adjacent members of the metallic skeleton. In the examination of arches it has been found best to work under the hypothesis of a partial separation in the action of the two materials, the metal and the concrete jointly acting to resist tension and compression in the various portions.

Unfortunately, the medal has its reverse side. The resistance of the reinforced concrete depends very largely upon the proportion of cement, the character of the sand, the methods of mixture, and the quantity of water. In order, therefore, to avoid deformations, it is advisable to increase the proportion of reinforcing members, and to increase the thickness over that which has sometimes been adopted. This naturally diminishes the economy of the method. In addition to this warning, it may be added that the best results demand a special kind of skill in the workmen, and consequently involve a proportionally greater expense. Notwithstanding the drawbacks, the method has shown itself to be an important advance in the art of construction.

ELECTRIC APPLIANCES IN SHIP-BUILDING YARDS.

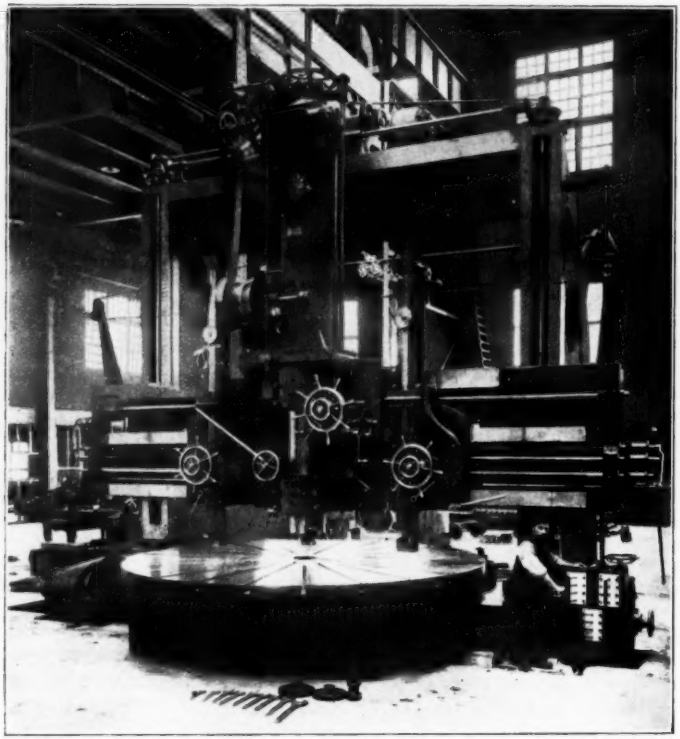
By Sydney F. Walker.

The introduction of improved labour processes into ship-building is of peculiar interest because here, even more than elsewhere, economy of manufacture may prove the determining factor in fixing or changing the centres of an enormously important industry. In the following article, Mr. Walker deals principally with applications common to other mechanical industries, but of new introduction into marine construction. A second article will deal with tools and operations more exclusively special to ship-building.—The Editors.



THE great ship-building industry is following the same course, with regard to the adoption of electricity, as other industries. It is feeling its way. Larger and larger apparatus are being entrusted to the care of the electrical engineer, more and more important work is being done by electric-driven machines. Electricity is being more used as its applications are better understood, and as it becomes more reliable. More men of the intelligent mechanic class are becoming sufficiently educated in the knowledge of electrical apparatus to keep them going, and this is producing its usual result—more and more appliances are being used in every industry.

Even now, however, when confidence in electrical appliances has been so far established that tens of thousands of pounds are spent on one installation, the feeling that it is wise to go slow in the matter still prevails to the same extent in all industries, and is shown by the fact that it is rarely thought wise at the present time, in Britain, to use an electric motor exceeding 50 brake horse power. This condition, of course, will pass away. The differences between generators and motors for electrical work are only in their application; and as generators individually converting some thousands of steam horse power into electric energy are in daily use, while the size of the generating units is steadily rising, the question of motors advancing to the same sizes, and larger ones, can be a matter of time and opportunity only. In the

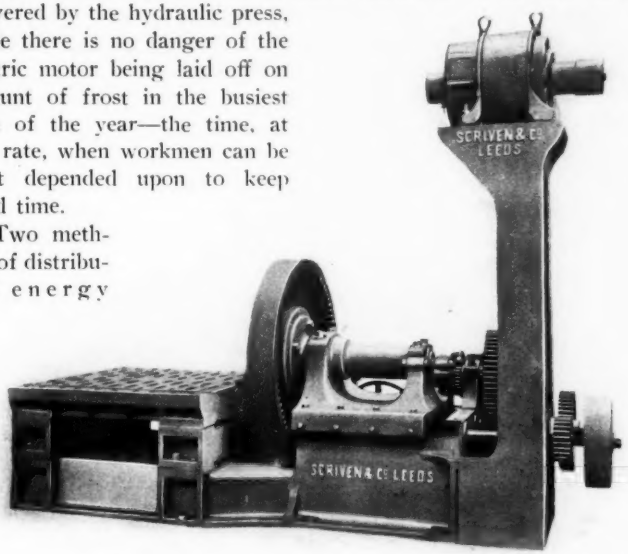


16-FOOT BORING MILL, ELECTRIC DRIVEN, NEW YORK SHIP-BUILDING COMPANY.
Niles Tool Works.

ship-building industry also the struggle which is actively in progress between the rival distributors of energy is well illustrated. Steam, the early form of distributor, is rapidly being relegated to its proper place—the generating power house. Compressed air has not come to the front in the same manner as it has done in mining work, because there is not the danger in connection with the ship-building that there is in mining, and it is only now being introduced, in a small way, in the form of small tools for drilling, rivetting, chipping, and similar work. Nevertheless, if the engineers who have the compressed-air matters in hand are as bold as the electrical engineers, and if compressed air is pushed as much as electricity is being pushed, it must become a very formidable rival to electricity. Hydraulic apparatus, which has justly held its own for so long in ship-building yards, will

also continue to be a formidable rival to electricity, and in particular in connection with work, (of which there is so much in ship-building,) in which a large steady pressure is required over a large surface for a short time. Yet even here, a little consideration will show that electricity, properly applied, will render a good account of itself. Hydraulic power has justly displaced steam power, because while the power delivered by a steam engine is necessarily variable through each stroke, that delivered by the hydraulic ram or press is constant within the limits of its useful range. But the power delivered by the steam engine is variable for the same reason that engine-driven plant often causes troublesome vibrations in the neighbourhood—the energy exerted by the piston is constantly varying, and it varies the more the greater the economy that is sought to be introduced. The steam-engine cylinder receives steam during only a portion of its stroke, and for the remainder of the stroke the energy delivered to the piston is constantly falling. With the electric motor, this variation does not exist. Provided the supply service is properly arranged, the motor is of proper size, and other arrangements also as they should be, the energy delivered by the electric motor should be as uniform as that delivered by the hydraulic press, while there is no danger of the electric motor being laid off on account of frost in the busiest time of the year—the time, at any rate, when workmen can be most depended upon to keep good time.

Two methods of distributing energy



ELECTRIC-DRIVEN MACHINE FOR FACING THE ENDS OF GIRDERS AND COLUMNS.
Takes work up to 30 by 26 inches. Scriven & Co.

that are used in other industries do not seem to have been taken up in ship-building, viz., rope driving and the use of high-pressure producer gas. It is very probable that the former of these will not, at this late date, be introduced into ship-building. It is a formidable rival to some other systems of power distribution in other industries, and might have been in ship-building if it had been pushed in earlier days. Now it would be very difficult to supplant the other methods. Producer gas, especially if delivered at high pressures, may also be a formidable rival. The possibilities of the economy of high-pressure gas are hardly appreciated as yet. The Glasgow exhibition afforded a very striking illustration of its possibilities in the direction of lighting, and power distribution should follow, if gas engineers are not too full of work in other directions. At Glasgow, a large portion of the grounds was lighted by means of Welsbach burners, supplied with ordinary town gas at from 8 to 10 inches water gauge, and the effect was brilliant and the method economical. It is doubtful, however, if the place at which the producer gas should be consumed is not in the cylinders of engines driving electric generators, rather than in individual engines of various sizes. Apart from the question of the efficiencies of small engines worked with gas of any kind, the same question would come up—the uneven turning moment—at least in the case of machines in which hydraulic apparatus is now employed, and it would be necessary to use the gas engine to fill the hydraulic accumulator, just as the steam engine does now. All of the methods enumerated, however closely they may approach electricity in other respects, cannot approach it in the one point which has been the cause, primarily, of its enormous advance during recent years—its great flexibility, or, if the term be preferred, its great convenience. In ship-building this feature is especially valuable, as the work, if it is to be done economically, has to be done in many cases under so widely varying conditions. Or, to put the matter in another form, the ability to do certain portions of the work under certain special conditions, which electricity affords, spells economy very largely.

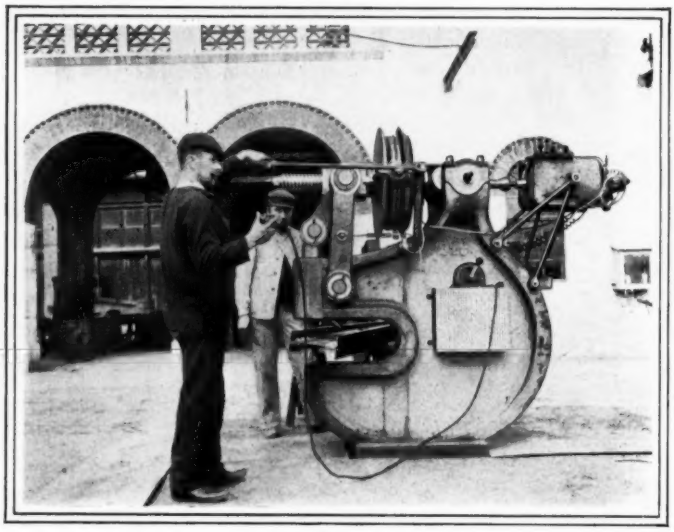
The building of a ship is probably like nothing else. A ship is a dwelling house, in which men spend a large portion of their lives. It is also a store house, in which are kept the belongings of the crew as well as those of the ship itself, and in which cargo may also have to be stored. The cargo may be of the most various forms, from petroleum in bulk, loose in tanks formed for the purpose, to the equipment of a fighting fort. The house has to conform also to certain conditions in its structure. It has to sit gracefully on, or rather in, the water.

Its construction below the water line must be such that, while it is able to carry the largest quantity of whatever its cargo may be, it must also offer as small resistance as possible in its passage through the element in which it sits. Further, in order that it may be driven through the water at the highest possible speed, its lines must conform to certain principles. It must have something of the build of the fish about it, though the fish must be beaten upon its own ground if possible, and as far as possible. And this leads to the beautiful lines and the graceful curves that are seen in the outlines of all vessels that are intended to travel swiftly through the water, the extreme case of which is seen in the curves of the yachts which have been contesting the supremacy of the yachting world.

LARGE HORIZONTAL BENDING ROLLS, ELECTRIC-DRIVEN, IN THE SHIP-BUILDING YARDS OF THE MARYLAND STEEL COMPANY, SPARROWS POINT, MARYLAND.

The rolls are capable of bending plates up to 30 feet in length.

But all this, while the effects produced are charming, places considerable difficulties in the way of the designer and the constructor. The outline of the ship is made up of curves, varying in every part, and to these curves the steel of which the ship is built have to be worked; and here comes in the use of machinery, the question of the delivery of power to the individual machines, and the question of the use of electricity for the purpose. The lines of a ship near the bows, the curves to which plates, ribs, beams, etc., must be bent, are quite different from those in the neighbourhood of the stern, while both are quite different from the curves amidships.

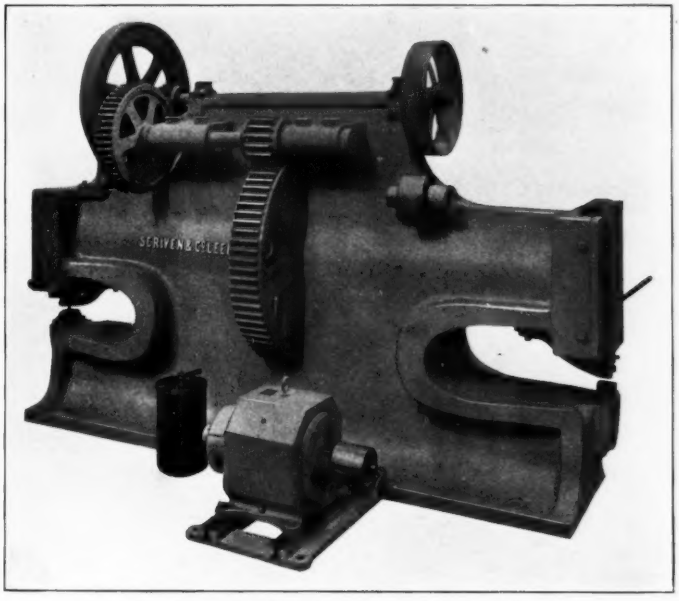


FIXED TYPE ELECTRIC RIVETTER, KODOLITSCH SYSTEM, AT WORK.
Courtesy of Mr. F. S. Dudgeon.

In the days of the wooden walls of old England, which have now passed away forever, the ship was built up entirely by hand labour. Ribs, beams, keel, keelson, stem, sternpost, outside timbers, all were cut by hand to the proper shape, and put into place by workmen whose great skill had come down to them more or less directly from the Vikings, from whom both Englishmen and Americans claim descent. But with the introduction of iron, and still more with the supersession of iron by steel, hand labour has gradually given way to machines. And as ships have become bigger and parts of ships have also become bigger, the necessity for machinery, ever increasing in size and in the power required to drive it, has become more and more accentuated. Sir William White, in his presidential address to the mechanical section of the British Association for the Advancement of Science, in 1899, mentioned a striking incident which had come under his personal notice, when he was a boy in the Royal dockyard. It was sought at that time to introduce a machine to cut out the ribs of ships that were built for the Navy, but after an extended trial it was given up, as it was found that the men who were accustomed to cut out the frame timbers could beat the machine. Such a thing could not happen now. It is thought that the race has deteriorated, owing to the

exodus into the towns since those days, but even the strongest group of the men of those days who could have been collected round a modern plate, 28 feet long and weighing from 2 to 3 tons, could do very little in an economical sense. Prof. Biles, in his exhaustive and interesting series of articles in THE ENGINEERING MAGAZINE, has explained the methods of moulding the different parts of a modern ship, and he has explained how each plate and each portion of the frame of the ship has to be handled by successive machines, and passed on from point to point, till it is at last firmly fixed in the position it is to occupy as part of the general structure. There are three portions of the work of building a modern ship, therefore, in which electricity is at present used to a moderate extent, (moderate only in proportion to the whole), and in which it will probably increase in use, while there are also portions of the work to which electricity has not yet been applied, but to which, in my opinion, it is more than probable that it will be applied in the future. The portions of the work in which it is used now are:

1:—Driving individual machine tools for performing the various operations through which the frames and outside plating have to pass.



DOUBLE-ENDED ELECTRIC-DRIVEN PUNCHING MACHINE.
Punches 1¼ inch holes through 1¼ inch steel plates 36 inches from the edge.

ELECTRIC-DRIVEN PUNCHING MACHINE, NEW YORK SHIP-BUILDING COMPANY, CAMDEN, N. J.

2:—Operating tools that are used to complete the work which has been partially performed in the machine shops, these operations taking place upon portions of the structure *in situ*.

3:—Furnishing the power required for handling the masses of iron and steel that have to be dealt with in the construction of a modern ship.

Steel is received from the steel makers in a form as closely approaching that in which it is to be used by the ship-builder as the steel maker can produce. But in the great majority of cases, as received

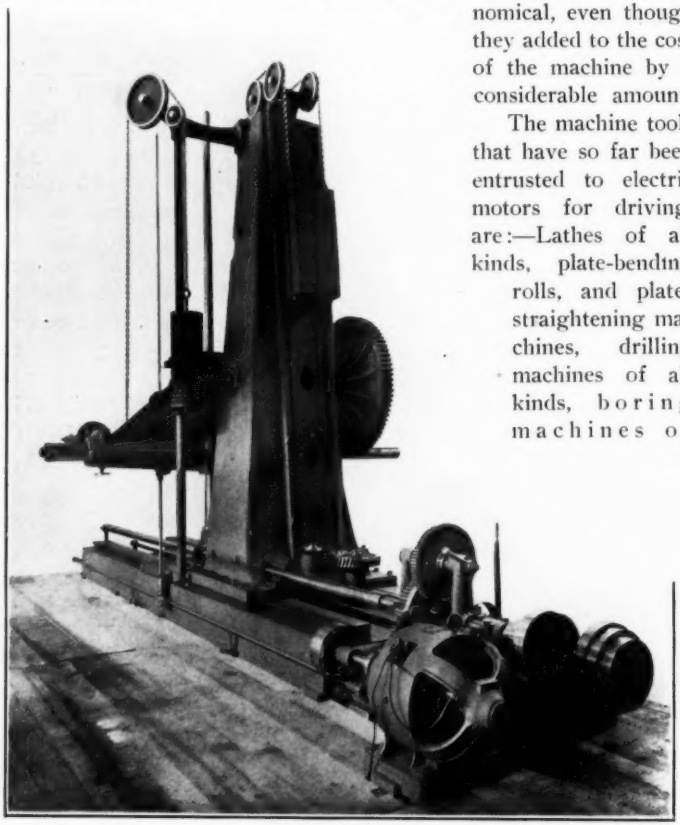
from the steel maker, even after handling by the latest modern plant at his command, H sections, T sections, angle sections, Z sections, and plates, are still in a more or less crude form, so far as the ship-builder's requirements are concerned. It is necessary for his requirements that the sectional portions of which the frame is built, and upon which the plates are fixed, should be of exactly certain lengths and moulded exactly to certain curves, or the desired contour of the ship when completed will not be attained. Plates, and bars of various sections also, are not always perfectly straight. Handling in the steel works and by the railway companies, or by the ship's companies where water carriage rules, do not add to exactness in these particulars.

The ship, when built, has to be driven through the water, and has to be provided with engines, boilers, and the numerous accessories that go to ensure economy and speed; and as ships have become larger, and the rate of travelling faster, engines and boilers have all become larger and heavier, so that the machines required for dealing with this part of a ship's equipment have also grown enormously. And so it has come about that a formidable series of powerful machines has come into existence, all seeking to economise labour, both in performing the different operations necessary upon the steel in its various forms, and also in the handling of the masses of steel themselves. Economy has also dictated that, where it is possible, two or more operations shall be performed by one machine, if possible at one setting. Arrangements which enable this to be carried out save considerable amounts in the cost of working the steel into the form of a ship. Thus machines are arranged to drill several holes in boiler, or ship's side plates, at one operation; to bore and turn at one operation, and to bore, turn, and mill at one machine, sometimes with one setting.

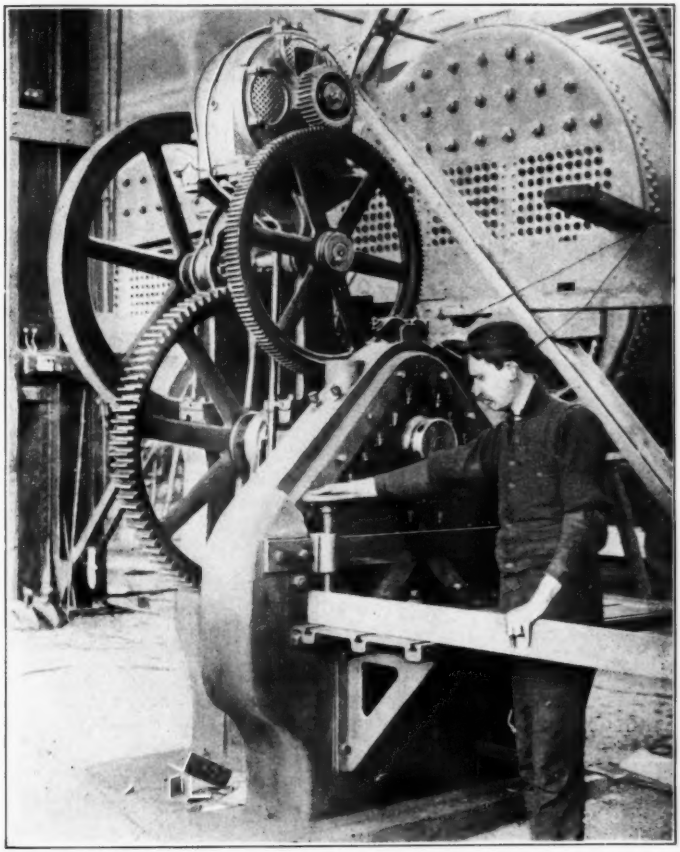
Machines are also arranged for straightening plates and sectional steel, for bending plates and sections to the required form, for planing their ends, for turning flanges on their ends, for bevelling, where the structure requires it, for shearing, punching, drilling, countersinking, for cutting the holes in plates for man holes, side-light holes, and similar operations, all of which, in the days of wooden vessels, were done entirely by hand labour. Electric driving is being cautiously applied to all of these machines, though up to the present only a portion of the machine tools in use have been entrusted to the care of electric motors. There is still a fear, on the part of those who are responsible for the turning out of work quickly, that electricity may fail them at the critical moment. Electrical engineers also have not always been wise in their generation. In many cases they have endeavoured

to do the work with motors that were too small and would not stand the strains which were brought against them, and in other cases they have failed to grasp the true significance of the flexibility of the electric motor. They have in many cases, until taught better by experience, tried to perform several operations by means of one motor, which could be much better performed by two or three. They have not appreciated the fact that an electric motor can be put into a small space, and can be made to almost any form, and that it uses nothing when it is not working, so that motors arranged for performing some of the operations that were performed by belts in the old days would be economical, even though they added to the cost of the machine by a considerable amount.

The machine tools that have so far been entrusted to electric motors for driving, are:—Lathes of all kinds, plate-bending rolls, and plate-straightening machines, drilling machines of all kinds, boring machines of



HORIZONTAL BORING, DRILLING, AND MILLING MACHINE, DRIVEN BY ELECTRIC MOTOR.
Niles Tool Works Company.

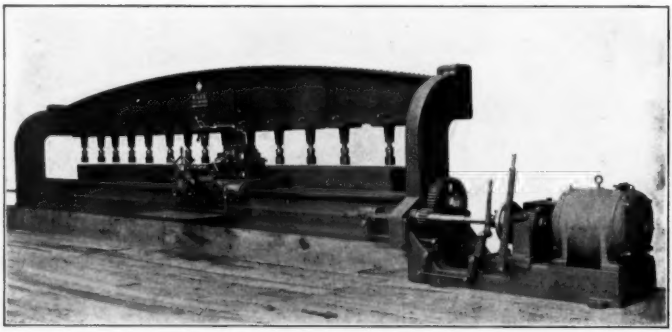


ELECTRIC-DRIVEN SHEARING OR CUTTING-OFF MACHINE, NEW YORK SHIP-BUILDING COMPANY'S YARDS.

Long & Allstatter Company, Hamilton, Ohio.

various forms, joggling machines (machines for forming the edges of two steel plates so that they will overlap each other, instead of lying with their edges together, very much after the style of the old clinker building in wooden days), bevelling machines, machines for cutting steel bars or plates to the required length, and others.

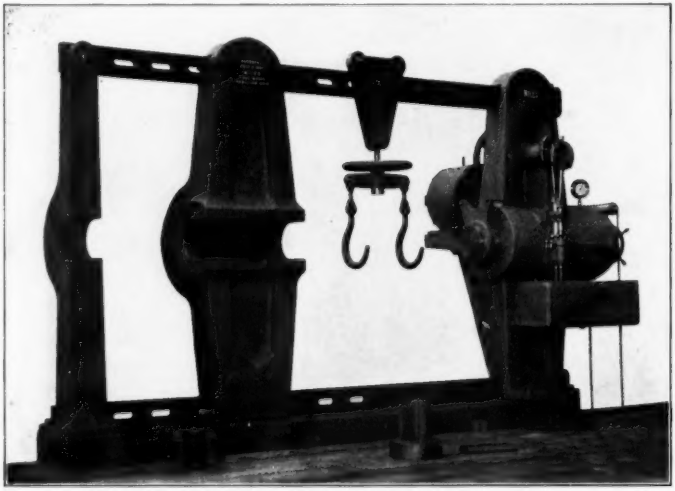
The above machines are all large and intended for heavy work, and the electric motor merely replaces the engine which previously drove the tool; and it goes without saying that this process of substi-



ELECTRIC-DRIVEN PLATE-PLANING MACHINE TO TAKE PLATES 25 FEET LONG BY 2 INCHES THICK.

Niles Tool Works Company.

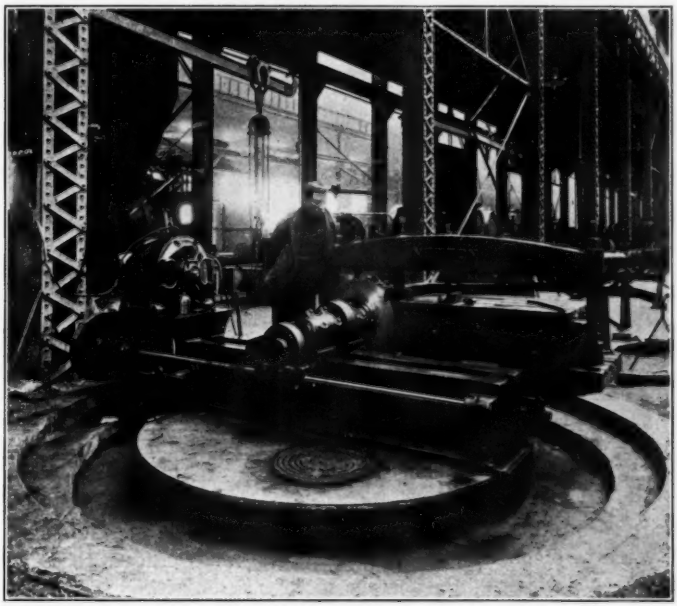
tution of electric motors for steam engines, where the latter have been used for driving machine tools can go on as far as ship-builders wish. The substitution, provided it is carried out in a proper manner, can mean only economy and convenience. The absence of steam pipes in the immediate neighbourhood of machine tools is in itself a great boon, leading to cheaper and better work and to absence of breakdowns.



SPECIAL HYDROSTATIC WHEEL PRESS, THE PUMP SUPPLYING THE RAM BEING DRIVEN BY AN ELECTRIC MOTOR.

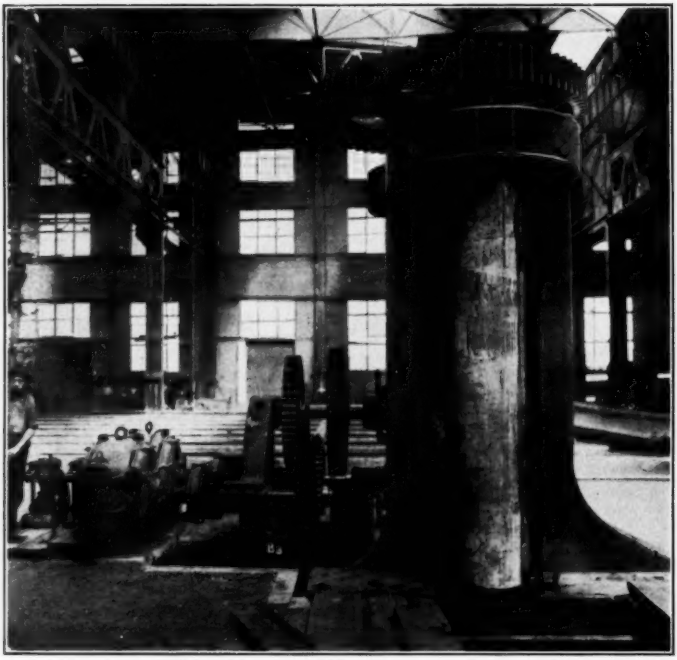
A modification is used for securing cranks on their shafts. Niles Tool Works Company.

But in addition to the heavy machine tools which demand their own motor, because they have had their own steam engine, ship-building yards are also applying electric motors very largely to driving groups of machines of smaller size, the individual machines taking their power from a line of shafting. This is merely a transition stage, so far as a large number of machine tools is concerned. It usually happens in every industry—and ship-building is no exception—that it is difficult to get managers to spend money on new plant except under pressure



ELECTRIC-DRIVEN COLD SAW, NEW YORK SHIP-BUILDING COMPANY'S YARDS.
Newton Machine Tool Company's tool driven by Westinghouse motor.

of orders. Then this is the complaint of the electrical engineers who have done a lot of this kind of work—when the change is made, it must be done in such a manner as least to interfere with the running of the works. Hence it happens that in place of splitting up the driving from a line of shafting, the shafting and its belts are left in their place, and merely the shaft itself is driven by an electric motor, instead of by a steam engine or from some other shaft. Economy is realised in this manner, but not to the extent that it will be later on. In any machine shop, the absence of belts and of the necessity for having all



HEAVY VERTICAL STRAIGHTENING OR BENDING ROLLS DRIVEN BY WESTINGHOUSE ELECTRIC MOTORS.

New York Ship-Building Company, Camden, N. J.

machines in one line is a great advantage. Absence of belts enables the whole of the machine shop to be swept by an overhead crane without inconvenience, and the absence of the necessity for having all machines exactly in one line practically increases the space at the disposal of the works manager. He can fit machines according to convenience. There is a limit below which it is not wise to multiply motors in electric driving, and this limit will vary with each individual works; but it may safely be stated that, except in special case, machines taking more than 4 horse power to drive will pay for separate motors, while there are cases where it pays even to divide up considerably more than this. Groups of machines turning out the same parts may usually be driven together, but the division in these cases should be such that the stoppage of one motor does not stop the works for the want of the particular parts.

MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

I. A RATIONAL AND ECONOMICAL SYSTEM FOR CONTROLLING FACTORY DETAIL.

The importance of Mr. Carpenter's subject needs no argument; the title is all sufficient. It is the problem which faces every manager—to carry on his works not only to mechanical success but to practical, financial prosperity. Mr. Carpenter writes from experience in an enterprise which stands as a model of business success, of excellence in mechanical quality of its output, and of enlightened methods of labour handling. He deals with actual working methods tested by the severest conditions of daily shop use. He gives proved solutions of the concrete, physical problems of organising the factory and handling the processes of manufacture with the greatest economy, certainty, smoothness of operation, and clearness of record. His articles will be practical shop papers by a practical shop supervisor. The next article will take up a concrete working example of the system outlined below; following numbers in the series will treat of the receipt and issue of stock, machining, tools, inspection, assembling, scrappage, inventions, piece work, and costs.—The Editors.

ORGANIZATION is the most potent force in the commercial world to-day. Its true principles will develop a power well-nigh illimitable when intelligently and properly applied to any form of business. Many firms now recognize the fact that very large economies can be effected by the introduction of rational and efficient factory systems which will properly care for the highly important details of factory work. Few are they, however, who fully realize how great might be the increase in the efficiency of their organization, and how large the consequent economies, did they but possess a system of factory organization and management founded upon principles which tend to develop at least an approximation to that ideal condition where every man—workman, foreman, and superintendent—is constantly working toward one common end—"The good of the company."

The question of the proper formation of such an organization is of vastly greater importance than the perfection of details of factory systems, great though this latter may be as a factor in the success of a business. If the system of organization is founded upon the correct principles, the perfection of the details will follow as a natural sequence.

One can but admire the wonderful systems of organization and management by which the present enormous business interests of the United States are governed. In this will be found one of the chief reasons why American corporations will live and excel in the business world. It is of great interest to note that the system of organization and management advocated in this paper has been developed along the same lines as those followed by these large concerns. In this case, however, the same principles are worked out in much greater detail and are put into effect in the management of the factory and working force. The results are as admirable and profitable in the mill or factory end of the business as they have proven to be in the organization of the executive branches. The great power of these immense business interests will be but partially developed so long as these ideas are not applied to their fullest extent to the executive, recording, and working forces alike.

Many a firm is today staggering under a load imposed upon it by bad and inefficient systems, both of management and of details of factory work. Some will not awaken to a full realization of the situation until some finely organized competitor drives them to the point where an investigation of "what is wrong" is absolutely necessary. Many a manager is asking himself the question: "How and why is it that our competitor, who is working under practically the same conditions that we are, can undersell us and still make a profit?"

Even where competition is not serious the live manufacturer has an uncomfortable and often justifiable feeling that he is neither securing the results from his system of management that he desires, nor making the profits from his products that conditions warrant him to expect. A number of questions press him for answers. Is his entire force working together in hearty co-operation with the management? Is his system of management capable of maintaining its growth and efficiency with the expansion of the business? Are his factory systems such that the very best results are being obtained? Is the output as large and the quality up to as high a standard as his expenditure warrants him to expect? Are his workmen giving him a full day's work? Is his piece-work system thoroughly reliable, and does it extend over as large a percentage of the work as possible? Is the inspection of parts thorough and inexpensive? Is his stock-tracing system sufficiently effective to prevent altogether vexatious and expensive delays? Does he know what stock is scrapped and why? Are his costs accurately compiled and calculated? Are all of the parts produced in the cheapest manner, and in such a way as to make them interchangeable?

Under the ordinary systems it is impossible for men to come in close enough contact with all the enormous amount of detail incident to any large business, to enable them to possess that knowledge of factory efficiency that is so absolutely necessary to obtain the best results. The business has, in many cases, grown to such an extent that the old systems which proved fairly satisfactory when the business was smaller and personal attention could be given to important details, are altogether inadequate to meet all the conditions arising with the growth of the business.

With this growth, the development of a system of factory management that will bring forth the latent efficiency of the organization, and also of simple and inexpensive factory systems that will enable the management to keep in close touch with the work in the factory, and give to the manager or superintendent the very necessary assurance that the work in all its details is being carried out in the most efficient manner possible, will prove invaluable. These results can be accomplished only by the adoption of up-to-date methods of organization. The large savings and increased efficiency resulting from the introduction of such systems have been absolutely demonstrated, when the particular conditions of the business were studied and systems introduced by those whose experience fitted them for this important task.

It is certainly not my claim that any system, or series of systems, will in itself prove a "cure-all" for defective factory management. The disposition and ability of the men upon whom devolve the duty of putting the systems into effect must always be taken into consideration. Their co-operation must be secured before the success of any attempt to reorganize the working force is assured. Unless these men are taken into the confidence of the management, unless they are convinced that any proposed change will prove of material benefit to them and the organization, they will oppose any attempted improvement and it will inevitably be deprived of its most beneficial features.

In this paper will be presented a number of ideas on the subject, which, upon development, will prove their efficiency in enlisting the sympathy and hearty support of the superintendent, foreman, and assistants in the work of the company, and in developing an organization, strong, flexible, capable of expansion, and having in it those fundamental principles which, when developed, will result in as near an approach to our conception of a perfect organization as we may ever expect to secure.

Defects of Organization:—The defects of factory organization can be grouped into two general classes:—First, the narrow and defective methods by which the factory organization has been developed; second, the lack of broad and efficient factory systems by which the work can be done in the best and cheapest manner possible and the management kept closely informed as to the important details of the factory work. We will first take up a few of the most serious faults that exist under the ordinary system of organization and management.

Superintendent and Assistants:—In very many cases the superintendent is loaded down with detail work that either he or the management considers he should attend to. This is often carried to such an extreme that he cannot give his attention to the larger and broader problems for which his education, experience, and ability fit him. His assistants are often not given sufficient authority, or they are men who are not strong enough to be trusted with responsibility. There is lacking in many cases that feeling of co-operation between these men which is such a strong factor in an efficient organization. At times we can even find a man who has the idea that his own position is strengthened by not having strong assistants, and by keeping all the important details of the work in his own head. Repeating the trite saying of a prominent manufacturer: "The bane of factory organization is he who keeps all important and necessary information under his hat, whether he be workman, foreman, or superintendent." The result is that very often when the man and the hat go out the front door, the desired information goes too and the efficiency of the organization is seriously impaired until the problems can be taken up and solved by others.

Lack of Discussions:—The most serious mistake in most organizations is the fact that consultations with foremen and assistants are held so seldom, and even when they are held, are confined to so few men. It is a fact that in very many cases no attempt is made to secure the great benefit that would be derived from obtaining the advice of many men of wide experience on subjects of the greatest importance to the organization. This defect must be remedied if the concern expects to get the best possible results from any system of management. A firm is adopting a very short-sighted business policy when it refuses to acknowledge the fact that decisions based upon the free discussion and deliberation of men of experience, are wiser, stronger, and much more effective than those of any one man. Serious consideration on the part of most business men will show them that serious and costly mistakes could have been avoided if they had but availed themselves

of the information possessed by all the experienced men in their establishment. The remedy for such conditions is as simple as it is effective and is the foundation upon which are built some of the most successful organizations of the present day.

Foremen:—There are a number of questions that usually confront an organization and its superintendent in regard to their foremen. There is often a lack of a proper degree of co-operation on the part of these men with each other and with the officials of the company. There exists a certain degree of jealousy of each other's acts and attainments which impairs the efficiency of the organization. There is often a lack of frankness on the part of the foreman in regard to their own mistakes. They do not give the workmen the proper encouragement to offer suggestions in the line of improvements, and they do not make improvements themselves.

Workmen:—The question of the proper handling of the workmen in order to secure the best results is one that is entirely too large to be discussed in this paper. This problem is still far from being solved. It is not hard to recognize the many difficulties of the situation, but it would be an altogether impossible task to set down any rules that would prove at all general in their efficacy. If space permitted, it would be profitable to study why the workers lack interest in their work; why they shirk and produce work below the standard, and why the suggestions for improvements are so few in number. However, a description of methods will be given by which the interest of a majority of the men can be vastly increased and a great gain effected in the general efficiency of the working body. To effect an improvement in an organization of a body of workmen, the methods adopted must be of such a nature that the men will find it is to their personal advantage to show their skill and facility in handling work, and feel certain that they will receive full credit for any suggested improvements. The methods must prove to them that they are considered a part of the organization, and that, if they but prove their ability, they will be recognized and advanced as opportunties offer. One of the worst features of the systems usually in force lies in the fact that the larger the organization grows, the weaker and more inefficient it becomes. It is a fact that the systems generally in use fail utterly to care properly for the important details of the business as it expands beyond the limits bounding it when they were installed.

Requirements for Good Organization:—In an organization constructed on the strongest and most efficient basis, the head must be supported by strong subordinates. These subordinates must have

the necessary ability to care properly for a large portion of the detail work that is so often forced upon the attention of the head.

Discussions:—The most important principle which can enter into the plan of any organization is the free discussion of important subjects by all who are competent for this important work. The benefits to be derived from such methods cannot be over-estimated. Not only does the organization get the direct benefit of decisions which are based upon the full consideration of the subject under discussion by men of wide experience, but it also receives the indirect but great good coming from the inevitable growth of interest on the part of the men in the affairs of their employers. Those concerned in these discussions must necessarily be greatly benefited by coming in such intimate contact with other men of equal capabilities. In fact, such a system tends to lift the entire body of men up to a higher plane. Again, it imparts great strength to the organization, inasmuch as information necessary to the welfare of the business is thus possessed by a number of men. It cannot be weakened by the loss of important men. The granting of this degree of responsibility to a number of men makes all others feel that there are greater opportunities for advancement, the consequences of which will be far-reaching.

In place of putting all the responsibility upon one pair of shoulders and depending upon the judgment of one man for the consideration of important questions that come up for settlement, the burden should be carried by a number of the best-informed and best-balanced men in the organization formed into boards, or committees, with power to act. Promotions whenever and wherever possible should be the rule. Every man from superintendent to workman should understand that ample opportunity will be given him to prove his worth and that no one can withhold this from him.

Suggestions and Complaints:—The greatest encouragement should be given to everyone to make suggestions and complaints. This is a most important question for any concern. Experience has shown that not only will these suggestions and complaints be a source of great profit to the company, but the effect on the men will be very beneficial to the entire organization. The recognition of their efforts will prove a great spur to them and to others, and not only will their interest in the organization be increased, but the augmented attention given to their work will invariably result in a better and cheaper product.

The organization should be capable of indefinite expansion, keeping pace with the growth of the business without becoming weaker

or less efficient in any way. Its strong brainy men should be automatically and irresistibly developed. It should have the capacity to respond to a sudden call for extra effort. Serious errors should be reduced to a minimum. There should be fostered and developed a strong spirit of co-operation and desire to take advantage of every opportunity to effect improvements and economies.

System Proposed:—To bring about these desirable results, I propose a system of organization that is built up and developed along lines that are diametrically opposite to the usual methods. It is in practice today, and has been for a number of years, under the most difficult conditions possible, and the results themselves provide sufficient proof of the fact that it is an unqualified success. The methods can be adapted with equal success to steel mills, manufacturing establishments, and, in fact, to any line of business.

Board of Supervisors:—In place of a superintendent and assistants there must be a governing board of supervisors. This must not be so large as to be unwieldy, five men in most cases meeting all the requirements. This board must be the supreme and final power in the factory, the only official in the organization ranking it in authority being the general manager. All important matters must be settled by this board after full discussions and a frank and fair expression of opinion on the part of each supervisor. All general complaints and suggestions should be handled by it.

One of the matters of greatest importance would be the close consideration of inventions, new designs, or new products of any nature. These should first be submitted to this board. Should they decide that it would be practical to build or produce the article, it should then be submitted to all individuals who by their experience and ability are fitted to pass judgment upon it, for consideration and thorough tests. All of these should submit complete written reports of their test together with any criticism or suggestion they might have to offer. Experience has shown that such methods will demonstrate the existence of defects and possibilities of improvements never suspected by the originator of the idea. Absolute rules must be made that under no circumstances will a new product be put forth which has not received a full and thorough test and the order and sanction of this board. Regarding the system from this standpoint alone, it is above criticism. Such methods will almost preclude the possibility of costly errors of judgment in placing upon the market products of defective design or workmanship.

This board should have a permanent chairman selected by the company, and all orders emanating from it should be issued in his name.

The chairman of this board should be the person highest in authority in the factory. Meetings of this board should be held at least four times per week and attendance at these meetings must be compulsory.

Duties of Members of Board:—Each member of this board should have certain departments allotted to him according to his particular ability and experience, over which departments his authority should be complete. Personal authority, responsibility, and the power to make quick decisions will not be interfered with in the least by this system if it be properly applied. In fact, it will tend to foster and develop all of these under proper conditions. The fact that all important matters must be brought before the board will force prompt settlement. Those in authority can be granted ample power to settle matters demanding immediate attention. Any important actions so taken, however, should at once be reported to the board.

Sub-Committees:—In most establishments the product handled is of a varied character, be it machines, steel, or what-not, and each type of product will have its own peculiarities and defects. All suggestions, improvements, or complaints relating to these products should receive the consideration of the most competent men in the organization.

These questions should not be handled by the board of supervisors alone: first, because they should not lose the benefit of the wide experience of their foremen in the factory who are most familiar with this and other lines of work; second, because we must never lose sight of the fact that from bottom to top there must be a steady development and selection of the strong and forceful men and the opportunities to bring these men forward must not be lost. It is necessary, therefore, to form a number of sub-committees to handle these questions properly.

These sub-committees should have as members the board of supervisors and the heads of departments who have the most intimate knowledge of these particular products. Other heads of departments should often be called into consultation in order to secure all possible benefit from their knowledge and experience. Each sub-committee should have as its chairman one of the board of supervisors.

The work of these sub-committees will be of the greatest importance. All improvements, suggestions, and complaints, referring to matters that properly come under the supervision of the sub-committees, must be considered by them and action taken in all cases. Changes in tools or in processes of manufacture should be absolutely prohibited without the sanction of the proper committee having this supervis-

ion, or in urgent cases, of the chairman. In the latter case such action should be reported to the committee later. Adherence to this rule will result in freedom from error, order, and a thorough understanding among those concerned, in place of costly mistakes and endless confusion. These committees should also consider any proposed changes in the product, or any invention relating to it. Reports of all inventions should be sent by them to the board of supervisors. Striking economies will naturally result from the discussions that will arise in these bodies. Experience has proven that the members will soon understand that their reputations are at stake in making decisions and their opinions will be singularly fair and free from personal bias.

The board of supervisors should have the authority to overrule any decision of the sub-committees, should it be deemed advisable.

Meetings with Foremen:—The supervisors should frequently hold meetings with their foremen in order to consider questions of interest to all, or to suggest economies that might be effected by all working in concert. By this system each member of the board will have the most intimate knowledge of affairs, not only in the departments under his own jurisdiction, but also in the entire factory.

General Committees:—This system of forming committees should be extended to the office departments and executive forces. The underlying principles will be the same, and the result of their application in these other co-ordinate branches of the business will prove equally effective. The firm gains by the many satisfactory conclusions reached; it gains by the development of the forceful men who will prove a tower of strength to the organization; and again it gains by inspiring all the heads of departments with the definite assurance that the man of brains will be noticed and advanced.

All committees should have an appointed time for meetings which must not be deviated from, the presence of all members being insisted upon.

General Meetings:—Meetings should be held at least once a month of the board of supervisors, heads of sales departments, and the officers of the firm, to consider prospects for new business, needs of the market in the way of new product, needs of the factory, records of output, costs, sales, and reports in general, which should naturally be submitted to the higher officials of the firm. There should also be instituted a general meeting of all supervisors and the heads and assistant heads of departments once every three weeks, where all matters of general interest to the organization should be freely discussed. In these meetings each head of department should

be prepared to make a statement as to the condition of his department and make whatever complaints he may deem worthy of consideration. It is very important to pay close heed to this latter point in order to gain all possible benefit from these meetings. The men should thoroughly understand that just complaints, which will lead to the correction of any faults, are honestly desired. Delays and mistakes occurring in the different departments should also be brought before these meetings for consideration and explanation. If a number of different departments are involved this is the safest and best way to get at the bottom of any difficulty and correct it.

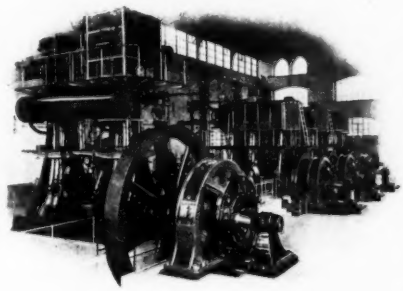
Such meetings tend to develop men still further. They become better acquainted with each other and with the officers. The jealousy that usually exists gives way to a clearer appreciation of each other's difficulties. There will often appear in its stead an earnest desire to help each other and an appreciation of the fact that their endeavors should be centered solely on doing that which will benefit the organization. They cannot but take greater interest in their work, as they will naturally feel that they are an integral part of the organization.

In the outline preceding has been given the framework of an organization which may seem to many managers a radical and dangerous departure from accepted ideas. The demonstration of its practical soundness can best be made from a working example, and the next paper in this series will take up a concrete instance of the adoption of this system for the distinct purpose of securing a stable, potent, and economical establishment for mechanical production.

ENGLISH, AMERICAN, AND CONTINENTAL STEAM ENGINEERING.

By Philip Dawson.

Mr. Dawson's articles began in THE ENGINEERING MAGAZINE for November, 1901. Of the three preceding papers, the first two discussed British steam engineering and traction plants, and the third Continental steam practice. The article following completes the present series. Next month we shall begin a most instructive and interesting series by Walter M. McFarland, late chief engineer U. S. N., on the Growth of Economy in Marine Steam Engineering.—THE EDITORS.



AMERICAN steam-engine power-house practice—the only division of our subject remaining for review—may properly be taken up from the point of the introduction of the Corliss valve. Probably the most important development in steam engineering since the days of James Watt was made by Joe Corliss in 1849, when he introduced his now so famous drop cut-off valve gear. The main features of this gear were the rapid and wide opening of the steam ports, the shortness and directness of these ports (which reduced the clearance to as little as 2½ per cent. of volume in the high-pressure and 4 per cent. in the low-pressure cylinder), the quickness of closure of the steam valves, and the adaptation of the main valve to the functions of a cut-off valve. This type is eminently a slow-revolution engine—for small sizes, not above 250 kilowatts, reaching as many as 135 revolutions per minute, for 800 kilowatts as much as 100 revolutions, for sizes up to 1,000 kilowatts running as high as 90 revolutions, and for larger sizes not above 75 revolutions per minute.

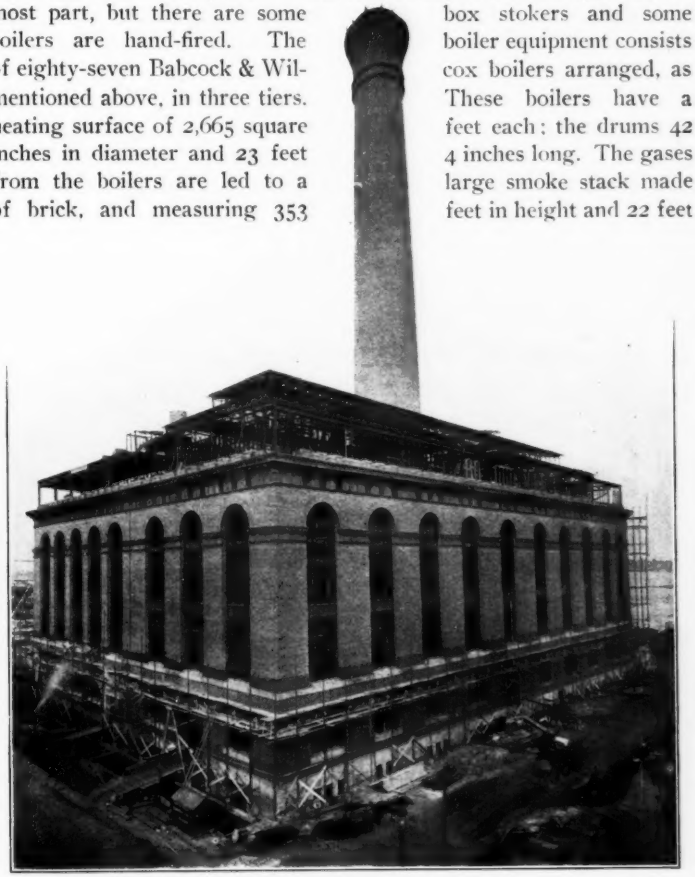
In the early days of dynamo construction up till, we may say, ten years ago, generators were small, a machine of 500 kilowatts being considered enormous, whereas now generators of as much as 5,000 kilowatts are being installed to run the Manhattan Elevated Railway at New York. The smaller dynamos of earlier days were all bi-polar, running a very large number of revolutions, certainly above 200, per

minute. Accidents to the electrical portions were frequent when it was customary, as it was in large installations, to drive two or more dynamos off one engine; and indeed in traction stations the use of a countershaft which enabled any steam engine to drive any set of dynamos was nearly universal.

As dynamo construction improved, engineers rapidly perceived the advantages to be gained by doing away with belts and ropes and by coupling the steam engine direct to the dynamo. America developed for this purpose a special type of high-speed engine, the first successful type of which was the Porter-Allen engine and the peculiarity of which was what is known as the flywheel type of governor. The first engines of this form were shown at the Philadelphia Exhibition in 1876. In this form of governor, weights revolving round the shaft in a vertical plane automatically vary the travel of the valve and cut-off by turning the eccentric round on the shaft. Then followed a host of inventors and of new types of engines such as the Armington & Sims, the Buckeye, the McIntosh & Seymour, the Ball, the Ide, the Westinghouse, and many others. With this type of engine, however, the steam economies obtained with the Corliss type of valve gear could not be rivalled. As dynamos grew in size and in economy and efficiency, and especially with the introduction of electric traction and power transmission, which necessitated dynamos running in many cases at an average load equal to 75 per cent. of their rated capacity, the question of steam-engine and consequent fuel economy became of the greatest importance. This necessity had been grasped much earlier by Germany than by the United States, and in 1888 Corliss engines direct-coupled to Siemens generators were already being run to light Berlin. The first use on any scale of such direct-connected units was at the World's Fair in Chicago, in 1893, where a 1,500-kilowatt generator was mounted directly on the shaft of a horizontal cross-compound Allis engine running at 75 revolutions per minute. Then followed directly the plants installed under F. S. Pearson for the Brooklyn stations, and the replacing of the belted by direct-driven setts on the West End Street Railway of Boston. Vertical engines, till within quite recent time, were far rarer in the United States than either in England or on the Continent. It would seem in the light of recent experience that for properly designed engines, certainly for sizes of 1,000 kilowatts and over, vertical engines should always be employed. The wear on the cylinder is reduced, as also the quantity of oil required, and with an automatic oiling system and a well-laid-out station the supervision of such engines will not be greater than would be the

case with horizontal ones. America now possesses a large number of stations in which vertical engines are running. No better example of such a station can probably be found than the 96th Street station of the Metropolitan Street Railway of New York.

The boiler house of this station contains three tiers of boilers, and above them, two large coal pockets or bins, each having a capacity of 5,000 tons. From these the coal is led to the boiler furnaces by chutes. The boilers are fired by mechanical stokers of the Vickars type for the most part, but there are some box stokers and some boilers are hand-fired. The boiler equipment consists of eighty-seven Babcock & Wilcox boilers arranged, as mentioned above, in three tiers. These boilers have a heating surface of 2,665 square feet each: the drums 42 inches in diameter and 23 feet 4 inches long. The gases from the boilers are led to a large smoke stack made of brick, and measuring 353 feet in height and 22 feet

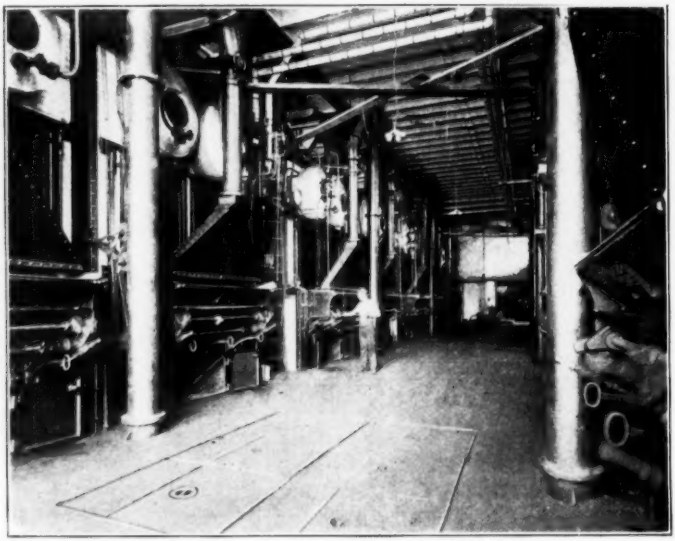


THE 96TH STREET POWER STATION, METROPOLITAN STREET RAILWAY COMPANY, NEW YORK.

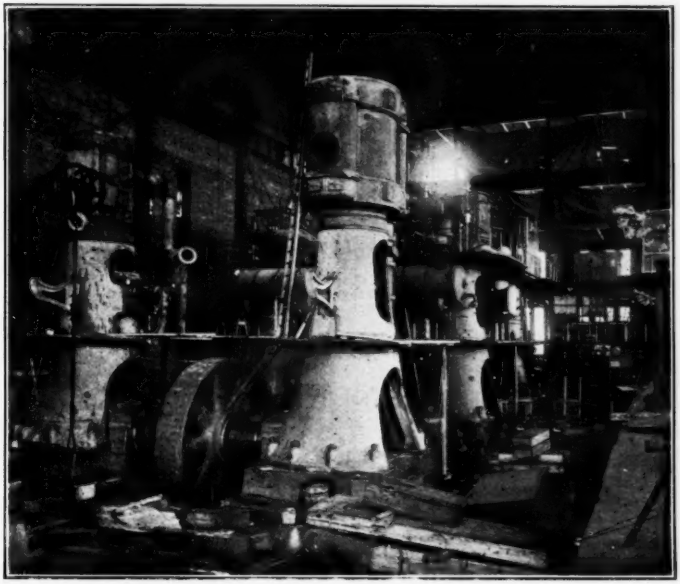
The illustrations of the station are by the courtesy of M. G. Starrett, Chief Engineer.

internal diameter throughout. The condensing plant consists of Worthington surface condensers and independent combined air and circulating pumps, each engine having its own condenser.

There are eleven engines, made by the Allis-Chalmers Co., of Milwaukee, each direct-coupled to one generator. These engines are of the vertical cross-compound condensing type, with the generator mounted on the shaft between the cylinders. Normally the engines give 4,500 indicated horse power when running at 75 revolutions per minute, with steam at 160 pounds per square inch; but they are capable of running continuously at 6,000 indicated horse power or for short periods at 7,000 indicated horse power. The cylinders measure 46 inches and 86 inches in diameter by 60 inches stroke. The shaft measures 34 inches at the journals, 30 inches at the cranks, and 37 inches where the generator and flywheel come; it is 27 feet 4 inches long, and has a 16-inch-diameter hole through its length. The connecting rods are 13 feet 8 inches between the centres. Both the cross-head and crank pins measure 14 inches diameter by 14 inches long. The flywheel is 28 feet in diameter and weighs 150 tons. The total weight of the engine and generator is 700 tons. The cylinders are not steam-jacketted; a reheating receiver is interposed between the high- and low-pressure cylinders.



BOILER ROOM, 96TH STREET POWER STATION, METROPOLITAN STREET RAILWAY.



PARTLY COMPLETED POWER STATION OF THE METROPOLITAN STREET RAILWAY COMPANY, NEW YORK.

The following details of the weights of the various portions of these engines may be of interest:—

Name of Piece.	No. of Piece.	Weight in lb.
Wheel centre, small half	1	21,000
" " large "	1	29,000
Segments of wheel (11 segments)	11	12,000
Lower frame	11	21,000
Slide section of frame	2	36,000
Bed-plate, large half	2	59,000
" small half	2	24,000
Low-pressure cylinder	1	28,000
High " "	1	15,000
Low-pressure-cylinder heads	2	26,000
High " " "	2	7,500
Shaft	1	72,000
Cranks, each	2	23,000
Connecting rods	2	9,000
Receiver	1	20,000

The steam piping is of wrought iron with steel flanges rivetted on; Van Stone joints are used. The drum of each boiler is connected to a 16-inch ring main by an 8-inch header; there are six of these rings in all, two for each tier of boilers. The rings are interconnected by eleven vertical 16-inch mains, which pass into the engine room and lead to

the engines, one main supplying each engine. The exhaust piping is of cast iron and is supported by hangers.

In comparing this station as a whole with similar installations in Great Britain and on the Continent, say with the Glasgow Corporation Tramways or Liverpool stations, or with the Berlin or Hamburg plants, it cannot be said that, taken as a whole, the comparison is entirely favourable to the 96th Street plant. The individual items, such as engines, boilers, steam piping, dynamos, switchboards, transformers, are beyond criticism; but the putting together seems in many instances to have been not as carefully thought and drawn out beforehand as is generally the case with a European plant. No pipe, however small,—no individual wire—is put into a European installation without a drawing being got out beforehand. Great trouble is constantly being experienced with American goods owing to the drawings, which the makers have supplied and which have been approved by the customer, differing widely from the real article when it comes over. It seems impossible to convince the American that, no matter how small the detail, it has been carefully laid out on the plans before construction commences, and that a difference in the goods he supplies from the drawings approved will throw out the whole system. Indeed in some cases, particularly on the Continent, working drawings have to be approved by the police authorities and the slightest deviation from them may entail the throwing out of the whole plant.

It is undoubtedly a fact that as regards finish, the European stations are far ahead of America. It is, however, also true that where, as is the case in Glasgow and Central London stations, European methods of installing American apparatus have been used, the finest results have been obtained.

The largest power plant in the world is now being installed at New York to drive the Manhattan Elevated Railway electrically, and a few details regarding this interesting railway are here given.

Steam is generated in sixty-four Babcock & Wilcox horizontal water-tube boilers, arranged in batteries of two boilers each; they are fitted with Roney mechanical stokers. The furnace gases pass through Green's economisers on their way to the chimney stacks, one economiser being provided for every two batteries. There are four brick stacks, each 278 feet high and 17 feet inside diameter. Forced draught is furnished by sixteen blowers installed by the Sturtevant Co., but the stacks are of sufficient dimensions to furnish the required draft under ordinary circumstances.

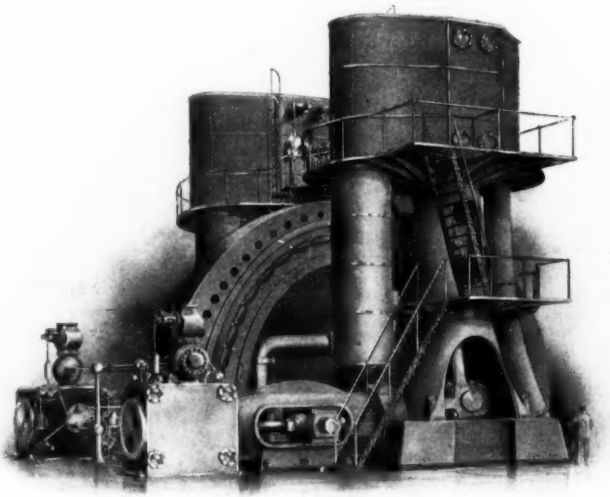
The steam piping is divided up into eight sections, each section

96TH STREET POWER STATION, METROPOLITAN STREET RAILWAY, NEW YORK.
One of the 5,000-horse-power Allis Corliss engines in course of erection.

dealing with four batteries of boilers and one of the main engines. Wrought-iron pipes up to 5 inches in diameter have cast-iron screwed flanges; from 5 inches diameter upwards, the flanges are welded on.

The engines were constructed by the Allis-Chalmers Company, of Milwaukee, and are eight in number. In design they are a radical departure from anything hitherto used in railway power plants. They are four-cylinder combined horizontal and vertical engines, consisting practically of a horizontal cross-compound engine and a vertical cross-

compound engine, both working upon the same crank shaft, except that the two vertical cylinders are both low-pressure cylinders and the other two both high-pressure. The cylinders measure 44 and 44 and 88 and 88 inches in diameter by 60 inches stroke. The speed is 75 revolutions per minute. The cranks, of which there are two are set at 135 degrees with each other. The power developed under normal conditions of running is 8,000 indicated horse power per engine. The exhaust steam is dealt with by jet condensers, driven by electrical motors.



COMBINED VERTICAL AND HORIZONTAL ALLIS CORLISS ENGINES FOR THE NEW ELECTRIC EQUIPMENT OF THE MANHATTAN ELEVATED RAILWAY, NEW YORK. ONE OF EIGHT UNITS.

Compare the Berlin tramway power-station engines, page 532, THE ENGINEERING MAGAZINE, January, 1902. Each engine is rated at 8,000 horse power for most efficient load, but will operate continuously at 12,000 horse power. Cylinders 44 and 88 by 60.

The Westinghouse Machine Company has recently built and erected some engines at Willesden for the Metropolitan Electric Supply Co., which should be briefly noticed. At these works there are four direct-coupled units, both engines and dynamos being of Westinghouse manufacture.

The engines are 2,500 horse power, vertical cross-compound marine type, with the alternator and exciter armature at the low-pressure end of the crank shaft, and a heavy fly-wheel governor at the other end

The cylinders measure 35 inches and 55 inches in diameter by 36 inches stroke. The crank shaft is 14 inches in diameter. The engine runs at 116 revolutions per minute. The exhaust steam passes into a Wheeler surface condenser, the circulating water being cooled in three Barnard water-cooling towers.

After having reviewed the general practice in Europe and the United States, separately, a few concluding remarks upon the practice of the different countries and comparison thereof is instructive. American engine builders as a rule use larger shafts and main bearings than is usual on the eastern side of the ocean. This is due to the fact that Americans have realised the necessity of flywheel effect, and that the engine and dynamo are built so as to be able to run 25 per cent. overload continuously, and 50 and 75 per cent. overload for short periods without injury. Furthermore, cross-compound engines are largely used with only two bearings—the armature and flywheel, which are next each other, being located between the bearings. The slightest wearing of the bottom shells or sinking of foundation might produce very heavy stresses due to magnetic pull. What these may amount to is shown from the following figures:—

Pull on shaft (from actual practice) due to 1/32 inch displacement of constant-current railway-generator armature.

Kilowatts.	Revs. per min.	Weight of armature in pounds.	Magnetic pull in pounds due to 1/32 in. displacement.
100	250	3,000	3,500
150	225	4,000	5,000
200	180	8,000	7,000
250	100	15,000	10,000
300	160	12,000	8,000
1,500	75	70,000	40,000

The clearance all round between the armature and pole pieces would be about 3/8 inch.

In consequence of marine engines having been built so successfully in Great Britain, when direct-connected generator sets had first to be considered the large shafts and bearing surface asked for were much ridiculed by many engine builders. To a certain extent the same thing obtained on the Continent, owing to storage batteries being nearly universal and heavy overloads necessitating heavy flywheels therefore nearly unknown. It was contended that a marine engine driving a propeller had quite as hard work to fulfil as an engine direct-connected to a railway generator. Three things, however, were overlooked in this comparison.

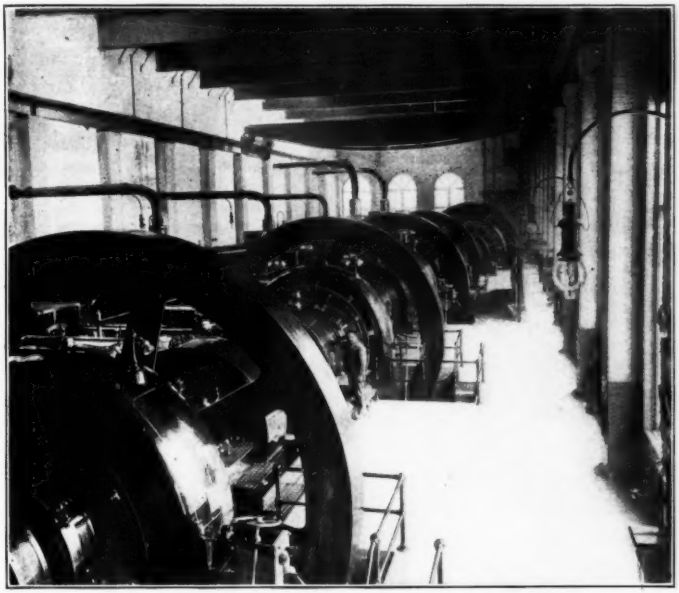
Name of Country.	Station kilowatts available for lighting and power.	Station kilowatts available for traction.	Miles of single track electrically equipped.	Number of motor cars running.	Total electrical station capacity available for all purposes in kilowatts.	Population of Country.	Area of Country in square miles.	Total approximate capital invested in pounds.
Great Britain.....	200,000	80,000	900	2,600	280,000	40,000,000	121,115	35,000,000
Germany.....	170,000	54,000	2,300	5,400	224,000	53,000,000	211,168	29,000,000
France.....	70,000	.....	800	1,300	95,000	39,000,000	204,146	12,000,000
Switzerland.....	30,000	7,500	250	330	37,500	3,000,000	15,469	4,500,000
Belgium	15,000	3,000	120	200	18,000	6,600,000	11,373	2,100,000
The whole of Europe.....	400,000	154,600	5,000	9,800	550,000	350,000,000	3,756,970	85,000,000
U. S. A.....	1,200,000	800,000	21,000	68,000	2,000,000	70,000,000	3,581,885	600,000,000

SOME COMPARATIVE APPROXIMATE FIGURES OF ELECTRIC LIGHT, POWER, AND TRACTION STATIONS IN EUROPEAN COUNTRIES AND THE UNITED STATES OF AMERICA AT THE PRESENT DAY.

First. A marine engine has a maximum load but cannot ever be instantaneously overloaded as much as 100 per cent., as often happens in traction work.

Second. The shaft, and consequently the bearings, have not to carry a heavy flywheel and armature.

Third. An immense extra stress can be exerted on the shaft should the armature get out of centre.



SOUTH SIDE ELEVATED RAILWAY, CHICAGO, POWER STATION.

Two 2,550-horse-power Allis cross-compound condensing engines, cylinders 34 and 70 inches by 54 inches, 80 revolutions, and four 1,250-horse-power Allis cross-compound condensing engines, cylinders 26 and 54 inches by 40 inches, 80 revolutions, all direct connected to Westinghouse generators. The maximum horse power of the larger engines is 4,000 and of the smaller 2,000; this is reached nearly every morning and evening during the winter months.

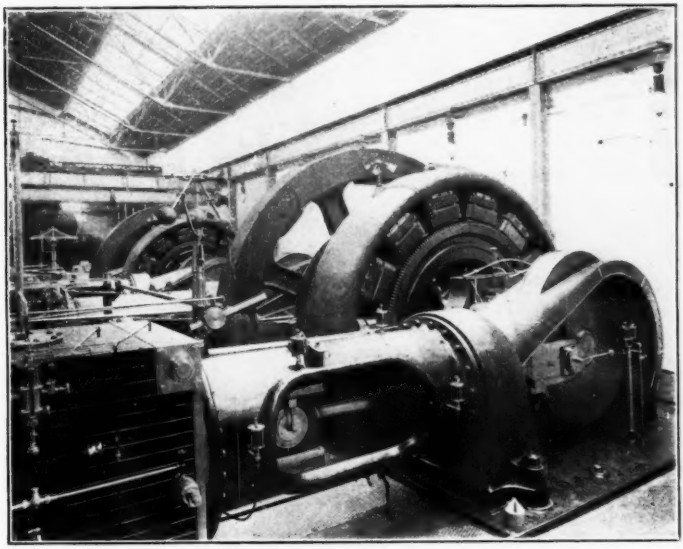
The pressure on the projected area, that is to say, on the area equal to diameter and length, of a main journal should in no case exceed 150 pounds per square inch. As regards crank pins and cross-head pins, American practice might with much advantage be altered, and the pressure per square inch of projected area decreased. The standard English mill-engine practice perhaps goes to extremes, but it is preferable to the American practice. As an example we will consider a cross-compound vertical engine designed to work at a steam pressure

of 150 pounds per square inch running 80 revolutions per minute. The cross-head pin in British practice would be 7 by 10 inches and the crank pin 9 by 11 inches. The corresponding dimensions of an Allis engine to do the same work and with same dimensions as regards cylinders, stroke, speed and steam pressure would be:—cross-head pin 6½ by 6½ inches; crank pin 6½ by 6½ inches. That this is large enough to avoid heating is undoubted, but if knocking is to be prevented the liners of these smaller pins will require taking up much oftener than would be the case with the British engine. Taking another example, say an engine designed to develop 800 indicated horse power and able to develop 1,000 horse power continuously at a pressure of 150 pounds steam at 90 revolutions per minute; this would have cylinders 22 by 44 inches and 42 inch stroke, cross-head pins of 6½ inches diameter by 7 inches long, and crank pins of 7 inches diameter by 7 inches length would give complete satisfaction. The standard American practice for such an engine would be crank and cross-head pins both 6 by 6 inches. Or, in other words and in round figures, the projected area of the cross-head pin should be 20 per cent. greater and that of the crank pin nearly 30 per cent. greater than standard American practice.

The outside finish of Continental engines, particularly, is much better than is usual with Americans. Nearly all bright parts are polished. The rim of the fly-wheel is polished. Burnished or Russian steel sheathing is used, and all the hand rails are bright. In connection with German engines it is interesting to notice that, owing probably to the prevailing depression in Germany which forces them to sell at any price, they have secured orders for steam engines in the heart of Lancashire at prices lower than either British or American tenderers, and besides they have accepted one-third of their payments in debentures.

Horizontal and vertical engines. In Germany some engineers state they will always use horizontal engines with tail rods carried on regular cross-heads and slides, because their original cost is less, and because the machine is less complicated and its working and supervision when running are easier. Had such complicated structures with two cylinders, one above the other, and highly complicated valve gear not been originally installed, it is doubtful whether such a conclusion would have been reached.

Continental engineers like to place a dynamo on each side of the engine. In some cases in cross-compound engines, as for instance Tosi, the two cylinders are side-by-side, and to look symmetrical some



PHILADELPHIA UNION TRACTION COMPANY POWER STATION AT 13TH AND MT. VERNON STREETS.

Four Wetherill twin tandem-compound non-condensing Corliss engines, cylinders 26 and 44 inches by 48 inches, 80 revolutions, direct connected to 1,500-kilowatt Westinghouse direct-current 550-volt generators. A fifth similar unit is now being installed.

engineers have even gone as far as to place the dynamo on one side and the fly-wheel on the other side of the engine, which it need hardly be pointed out is very bad practice.

In connection with the large combined horizontal-vertical engines which are being installed in the power stations of the Manhattan Elevated Railway at New York, it should be noted that the design there adopted is by no means novel, but is to be found, in much smaller engines it is true, in Germany, at Halle, where a similar type, although of relatively very small size, was being installed about 1892. Germany has adopted triple-expansion engines both for traction and lighting work. Also the use of superheated steam is greatly on the increase. The steam pressures used with these engines are 12 kilogrammes per square centimetre, about 175 pounds per square inch, and the temperature at the throttle 280 to 324 degrees centigrade, or a superheating of about 130 to 200 degrees Fahr. It is this degree of superheating which accounts, notwithstanding the complications frequently introduced, for the nearly universal use of poppet-valve systems on the Continent.

To increase the efficiency of steam plants, the Continental engineer has increased the vacuum of the condensers as much as possible and a far greater quantity of condensing water is used than is usual in America, the Continental practice being about in volumes 30 to 1 as compared to the American of 25 to 1.

Examining the types of engines in use. What is economy in a power and traction station? Engine economy guarantee at rated load is not the real measure, as loads are very variable. To ascertain what the real economy is we must know what is the variation in large plants and what is the average load on engines in these circumstances. Cross-compound condensing units give good results. The variation of temperature in the low-pressure cylinder is very small because of the reheater receiver. Such an engine is practically two single engines with each cylinder acted upon by a governor; it consists of two engines with smaller ranges of temperature variation. This is American practice. Engines for this class of work necessitate ample receiver capacity.

It has been suggested to adapt triple expansion to traction work and variable loads by using a throttle governor on the high-pressure, an automatic on the intermediate, and fixed cut-off on the low-pressure. A sudden overload would quickly raise the initial steam pressure and let out the cut-off on the high pressure; the intermediate automatic cut-off would provide the balance of power and deliver a fairly constant volume of steam at a slightly varying pressure; the cut-off being fixed and the vacuum constant, the range of temperature would be fairly constant. During the overloads such an engine would not be economical, but it would be so for the average load for which it was designed and to which it had been regulated.

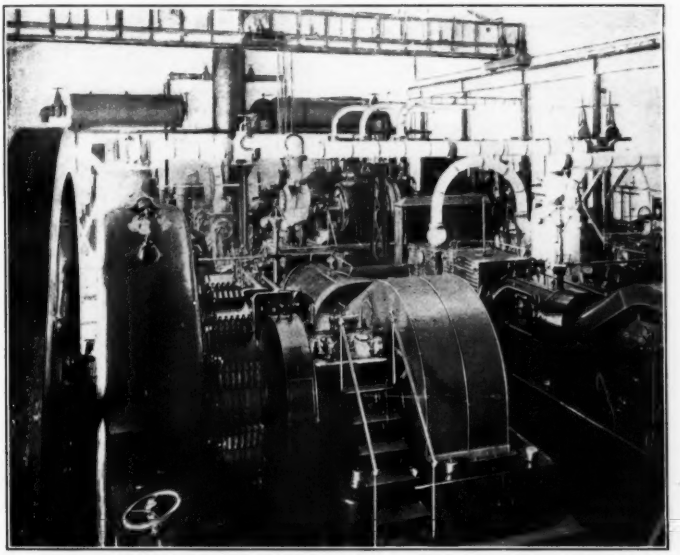
German and Continental engineers generally try to secure absolutely steady load by the use of large storage batteries, in which case triple-expansion condensing units are to be recommended, and also the use of superheated steam; but although this reduces the cost of the power generated, we must consider the extra cost of the power supplied, due to loss in accumulators and to interest, maintenance, and sinking fund involved by the installation battery. Where money is to be got at a low rate of interest, expensive fuel and water may indicate the use of batteries.

If superheaters are used in the boiler flues, economisers are not much good. If a separate superheater is used the cost of extra fuel, interest, maintenance, and sinking fund must be taken into account in considering economy in steam and coal.

In Great Britain, superheated steam is generally only used with

the idea of getting absolutely dry steam at the engines and doing away with the bother always caused by steam traps and separators. Consequently economisers are much used, and it is undoubtedly a fact that for compound condensing plants, economisers, when used in connection with mechanical stokers, give the best results.

Cooling towers and cooling ponds for condensing water are much in vogue on the Continent. In America cooling towers are also used as designed by Worthington, Wheeler-Condenser Co., and others, but with the difference that mechanical draft is created by the use of fans, whereas Continentals build their towers of wood and of sufficient height to create a sufficient draft.

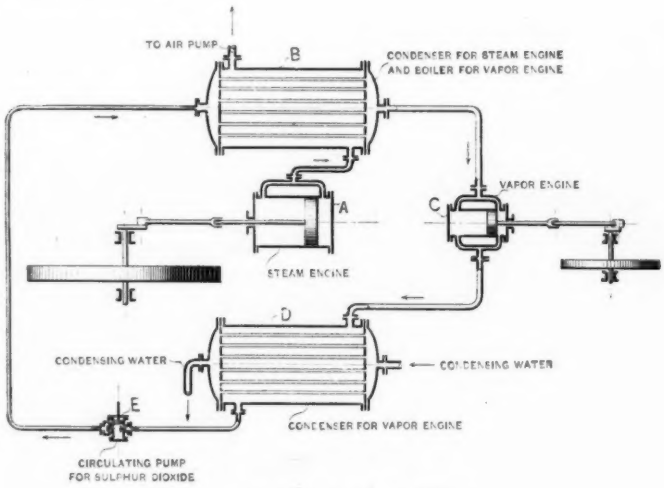


UNION TRACTION COMPANY, PHILADELPHIA. POWER HOUSE AT 33RD AND MARKET STREET.

Two Wetherill twin tandem-compound Corliss engines, cylinders 26 and 40 inches by 48 inches, non-condensing, direct-connected to 1,500-kilowatt Westinghouse direct-current generators; also one cross-compound condensing Corliss engine built by the Penna. Iron Works, cylinders 30 and 60 inches by 60 inches, 80 revolutions, steam at 150 pounds, direct-connected to a 1,500-kilowatt Westinghouse direct-current railway generator; also three Westinghouse "Kodak" units of 500 horse power each. This is not regarded by the company as at all an ideal power station, having grown up by accretion under urgent pressure. It is likely soon to be replaced by a thoroughly modern plant.

It is curious to note that in the case of the Berlin Electricity Works, where the greatest care has been taken owing to the cost of coal (over

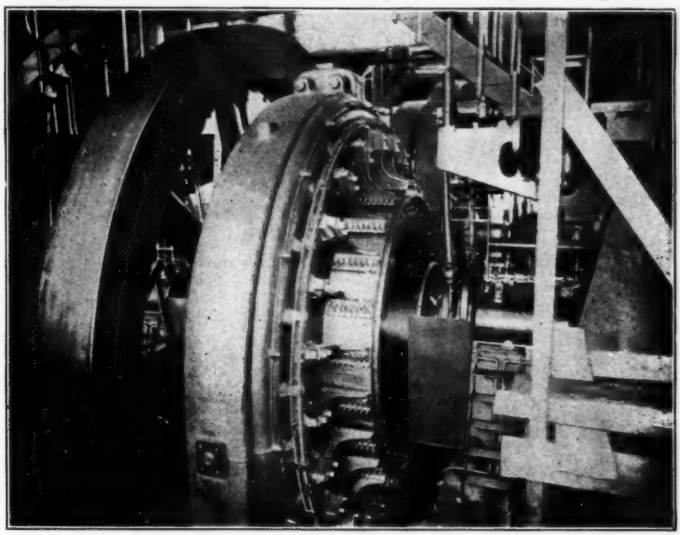
20 shillings a ton) to reduce fuel consumption, and where in view of the size of the plants small economies would soon mount up, the engineers in charge of these stations have stated to the writer that after careful tests they find it cheaper to stoke by hand, which they do in all their stations. British experience, which is confirmed by American practice, is to use mechanical coal-and-ash conveyors, in conjunction with weighing machines over each boiler, and to employ exclusively mechanical stoking.



THE JOSSE BINARY VAPOUR ENGINE.

The waste-heat engine being experimented with in Berlin is an entirely novel departure, and as it is being taken up by the Allgemeine Elektricitäts Gesellschaft on a commercial scale, I shall say a few words about it. Speaking broadly, the principle of this engine is as follows:—The exhaust steam from a steam engine is condensed in a surface condenser, which uses, instead of water as in the ordinary way, some liquid of a very low boiling point. The heat of the exhaust steam evaporates the cooling fluid and the vapour thus obtained is utilised in a separate cylinder, and useful work obtained from it. After a considerable amount of trial and experiment on the part of Professor E. Josse, of Berlin, SO_2 was selected as the most suitable material with which to work. Liquid SO_2 is therefore used to condense the exhaust steam, and being vaporised in the process is capable of doing useful work, either in a supplementary cylinder to the steam engine, or in a

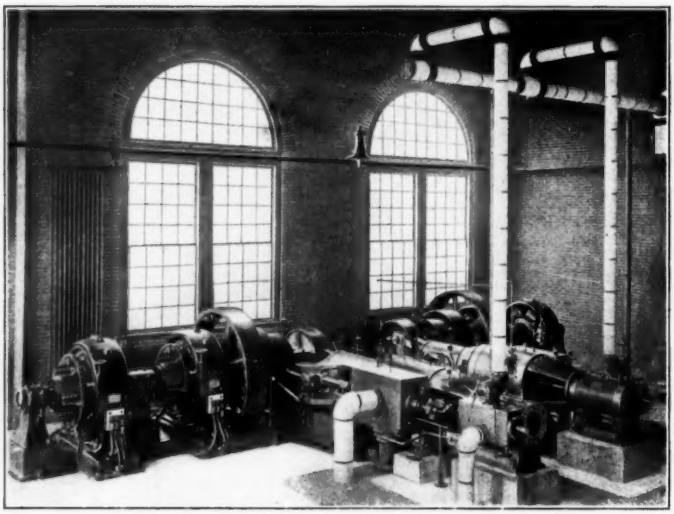
separate engine. The figure opposite, which is a diagramatic drawing of the general arrangement, should serve to make matters clear The steam engine A exhausts into the surface condenser B, through which flows liquid SO_2 instead of water; here the SO_2 is vapourised. The vapours so obtained develop power in a special cylinder C, by expanding down to a pressure approximately corresponding to the temperature of the circulating water. Under this pressure the SO_2 gas passes on to a second surface condenser, D, where by means of circulating water it is again liquified. E is a small pump which delivers the liquid SO_2 from the condenser D to the condenser B, from which point it commences its cycle afresh. Hence, neglecting loss by leakage, the working medium can be used indefinitely without replenishing.



BOSTON (MASS.) ELEVATED RAILWAY, LINCOLN POWER STATION.

Two Rice & Sargent engines driving one General Electric and one Westinghouse 2,700-kilowatt direct-current dynamo. The engines are duplicates, with cylinders 44 and 88 inches by 60 inches stroke, 75 revolutions, 160-pounds to 180-pounds steam pressure, 4,000 horse power.

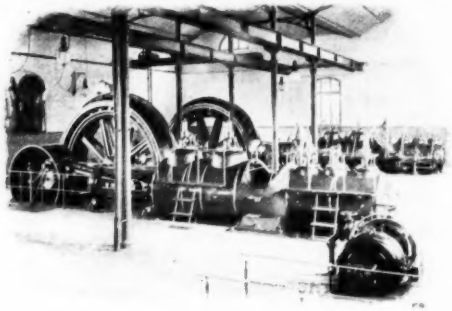
In theory this is all perfectly simple, but in practice it is not quite so easy. SO_2 in the presence of air and moisture rapidly changes into H_2SO_3 (sulphurous acid), which attacks metals, so great precautions had to be taken to render leakage impossible. This was a work of time, but eventually Professor Josse, to all intents and purposes, overcame these and other mechanical difficulties and has obtained some



AUXILIARY PLANT, BOSTON ELEVATED RAILWAY SYSTEM.

excellent results from experiments made under his superintendence. There is one great advantage about liquid SO_2 in that it is an excellent lubricant in itself. Professor Josse claims to have obtained an increase in power of an ordinary steam engine of from 30 to 34 per cent. by using his supplementary cylinder working with SO_2.

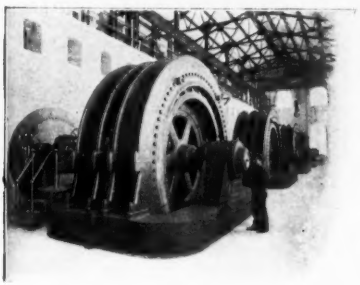
It is hoped that the foregoing remarks will be taken in the spirit in which they are written, namely, of friendly criticism and praise—an attempt to point out the faults and good points in all cases. That the engine builders of all countries have succeeded in developing in their respective branches and countries such magnificent machines is a fact of which all engineers without national distinction should be proud.



THE ECONOMY OF ISOLATED ELECTRIC PLANTS.

By Isaac D. Parsons.

In connection with Mr. Parsons' preceding article in our January number, we called attention to the rare value his analysis of costs possesses by virtue of its concentration of absolutely accurate data only, out of a very large range of investigation. This article concludes the discussion by a review of the yet more difficultly accessible field of the power plants installed in residential buildings.—THE EDITORS



HAVING in the previous article discussed comparative cost of public and private electric supply as obtained from exact records of the business buildings of New York, the buildings which are used for residential purposes, including apartment houses, hotels, and clubs, will now be considered. The apartment houses will be discussed first. Great difficulty was experienced in obtaining any figures from these buildings, and of one hundred and fifty first-class apartment houses over five stories in height which were visited, not over fifteen had plants installed, and of this small number all but three were complicated by hydraulic elevators or had no reliable records of output or supplies. That so few plants are installed in apartment houses is due principally to two causes. First, the load in such buildings is somewhat unfavorable for a plant, thus rendering its advisability doubtful; and, second, many of the apartment houses, especially in the up-town districts, are built with the intention of selling them as soon as possible. If a plant is installed it adds considerably to the original cost of the apartment house, and instead of being an inducement has been found to be a hindrance to the sale of the building. No plant is therefore installed when the apartment house is erected, and the building, in most cases, is so arranged as to render the installation of a plant at any future time either impossible or a matter of much difficulty.

Building No. 10 is representative of a type which includes more than half of all the better-class apartment houses in New York in which

All buildings heated by steam. All engines simple non-condensing and all direct connected to generators except in building No. 17, where they are belted.

Building number	10	11	12	13	14	15	16	17
Type of building	Ap't H'se	Ap't H'se	Ap't H'se	Hotel	Hotel	Club	Club	Club
Number of floors	7	10	11	6	9	5	3	4
Ground plan	90x65	44x81	50x200	100x200	25x60	35x100	75x200	110x100
Number of electric elevators	1-15 H. P.	2-20 H. P.	3-25 H. P.	.....	2-15 H. P.	.....	1-20 H. P.	.....
Floors of building lighted	All	All	All	1st & 2d	All	All	All	All
Number of Generators	2	2	3	2	2	1	3	2
Total capacity of generators, kilow	45	60	175	66	80	20	130	50
Average load on generators	.48	.20	.60	.50	.67	.40	.40	.75
Voltage	115	240	115	118	115	116	118	118
Type of boiler	Hor. Tub.	Marine	W. Tube	Hor. Tub.	Hor. Tub.	Hor. Tub.	Hor. Tub.	Hor. Tub.
Boiler pressure	90	100	125	90	100	80	90	80
Back pressure	5	2 to 5	3 to 5	4	3 to 6	6	3 to 5	3 to 5
Kind of coal	Pea	Buck	Buck	Pea	Bitum.	Buck	Buck	Buck
Load factor of lighting load	.43	.40	.40	.60	.67	.50	.44	.85

Cost of light, heat and power, with plant installed.

Time covered by figures	1 year	6 mos.	1 year	* 10 mos.	1 year	5 mos., '00	5 mos., '01	1 year	1 year
Labor	$2,280	$1,320	$3,840	$480	$3,690	$325	$325	$2,700	$2,400
Coal and removal of ashes	1,995	936	5,563	620	5,530	263	389	1,355	1,551
Water	164	64	303	60	486	22	30	117	196
Oil and waste	136	72	240	92	339	6	6	56	90
Lamps	28	8	136	40	354	5	6	24	93
Repairs and sundries	45	46	200	50	500	16	16	112	90
Interest and depreciation	572	495	2,376	880	1,045	115	115	1,100	770
Central station service		300							584
Total	$5,220	$3,241	$12,658	$2,222	$11,944	$752	$887	$5,464	$5,774
Output—Light K. W. hours	55,730		182,360	115,000		6,306	9,407		68,513
Output—Power K. W. hours	26,400		50,000						
Output—Total K. W. hours	82,130	26,605	232,960	115,000	329,500	6,306	9,307	93,800	68,513
Cost per K. W. hour	$0.064	$0.120	$0.055	$0.019	$0.037	$0.12	$0.09	$0.057	$0.084
Tons of coal consumed	570	312	1,919	1,007	1,826	75	111	466	486
Pounds coal per K. W. hour	15.5	25.1	18.4	13.5	12.4	26.7	26.4	11.1	16.6

Probable cost of light, heat and power for same period if no plant installed.

Central station bill	$7,351	$2,199	$11,330	$5,750	$15,650	$753	$908	$7,770	$5,841
Labor	600	300	1,600		1,300	125	125	720	720
Coal	650	672	1,400		150	240	240	910	600
Total	$8,601	$3,171	$14,330	$5,750	$17,050	$1,118	$1,273	$9,400	$7,161

* These figures are the cost of generating electricity only and do not include the cost of heating.

TABLE 4. POWER EXPENSES AND OUTPUT FOR ONE YEAR OF EIGHT RESIDENTIAL BUILDINGS.

elevators are installed. The dimensions of the building, as well as a general description of its plant, are given in Table 4. The figures of both kilowatts output and expenses were obtained from the chief engineer and superintendent. The output was calculated from ammeter readings. Steam is used for heating the building, for the generation of electricity, and for a small house pump. The expenses of running the plant and heating the building, and the output of the plant for one year, as well as the probable cost of running the building were no plant installed, are given in Table 4. The gain by the installation of the plant is thus $3,381, or 40 per cent. of the total cost of running the building were current supplied from the central station.

The figures concerning building No. 11 show how, principally through a mistake in installation, a very similar plant is operated at a loss. The plant in this apartment house not only furnishes light, heat, and power for the building itself, but also supplies heat and light to the adjoining four-story house which is 25 by 65 feet in plan. The output was calculated from daily wattmeter readings and the expenses of operation were obtained from the superintendent. Figures as to output, unfortunately, were available for only eight months. In Table 4 are given the expenses of running the plant and heating the buildings for the six months from October to March inclusive. The cost per kilowatt hour, which is very high, includes the expense of heating, and since heating was necessary during all of the six months, this has some effect in increasing the cost to so large a figure.

Fortunately figures for the same year were available of the expense of heating an apartment house exactly similar to building No. 11 in shape and exposure, and differing from it in cubic contents by approximately 75,000 cubic feet, which is the volume of the adjoining house heated by the plant in building No 11. It has been found, as mentioned in the first article, that the amount of coal necessary to heat 1,000 cubic feet is practically independent of the size of the building, so that these figures can be used without error in calculating the total cost of running building No. 11, if electricity were obtained from a central station. These expenses are given in Table 4 and in further detail in Table 5, and when added to the cost of current, were it obtained from the central station, the sum is in most months considerably less than the cost of operating the plant. This entails a net loss during the year of $600 to $800. The boilers in buildng No. 11 were found by recent test to evaporate nine pounds of water per pound of coal, and both engines and dynamos are new and in good condition, so that the lack of economy seems due entirely to very low efficiency

caused by light load on the generators. A comparison of the methods of operating the generators in this building and in building No. 10 will best show the reason for the difference in the cost of operating the plants. In building No. 10 the lighting load from 7 A. M. to 5 P. M. is on an average about 25 amperes, which necessitates running the smaller of the two dynamos, (one having a capacity of 130 and the other of 260 amperes) at about one-sixth full load excepting when the elevator is in use, when the generator is momentarily forced to its full capacity. At night the lighting load increases to about 180 amperes, which, with the elevator load, exceeds the capacity of the larger machine. Both generators are therefore run, one supplying the lights and the other the elevator, an arrangement which has the advantage of avoiding the fluctuation in the lighting voltage due to the elevator-starting current. The maximum lighting load does not exceed 200 amperes, so that the larger generator operates at night at 70 per cent. full load, and the smaller dynamo, when loaded at all, is loaded to about the same extent. This arrangement enables the machines to be operated with fair efficiency. The generators are stopped at about midnight and started again at 7 A. M., gas being used for lighting the building during the intervening hours.

In building No. 11 one of the two 30-kilowatt generators is in operation daily from 7 A. M. till midnight, and from 7 A. M. to 5 P. M. it carries both elevator and lighting loads. The other dynamo is used only from 5 P. M. till midnight, when it supplies either the elevator or the lights. Although the lighting load during the day is only 15 to 20 amperes, it is necessary to run a 30-Kilowatt generator, since when both elevators are in operation at once a machine of smaller capacity would be insufficient. The load on this machine during more than three-quarters of the time, from 7 A. M. to 5 P. M., is, however, but one-sixth of its capacity. During the evening, when both generators are in operation, the one furnishing power to the elevators is running for five hours out of the seven from 5 P. M. till midnight absolutely without load, and during the remaining two hours the average current furnished is not over 50 amperes, or less than one-half the machine's capacity. The lighting generator during the evening carries a load which never exceeds 60 amperes and it could be replaced by a 15-Kilowatt machine with considerable advantage. If we assume 12 per cent. friction loss in the engines and 85 per cent. full-load efficiency for the dynamos, the average efficiency of dynamos and engines combined is in this plant but 39 per cent., while the plant in building No. 10 shows an average efficiency of dynamos and engines combined of over 57 per

cent. Steam in both buildings is used only for heating, for a small house pump, and for the electric plant.

Table 5, in addition to giving the detailed expenses of building No. 11 for eight months, shows very clearly the important part which heating plays in the economy of the isolated plant, the coldest months when the most heating is necessary showing the greatest economy. The variation of the average daily load in building No. 11 from month to month and the change in load from day to day in January and October are shown in Figures 10 and 11 respectively. Though buildings No. 10 and No. 11 are very similar in size, it will be noticed that the yearly output in the former is much the greater, which is explained by the fact that the tenants of building No. 10 are furnished with unlimited light free, while in building No. 11 it is furnished to them at central-station rates.

Date.	K. W. Hours Light & Power Generated in Plant.	K. W. Hours obtained from Central Station.	Tons Coal used by Plant.	Pounds Coal per K. W. Hour.	Cost of Running Plant (includes cost of heating).	Cost of obtaining same number of K. W. Hours from Central Station.	Tons of Coal necessary for Heating only.	Total Cost of running Building with Central Station Service.	Amount Gained or Lost by Installation of Plant.	
June, 1900.....	2,961		30	22.6	469.59	280.10	6.0	348.10	Loss	121.49
October, 1900....	3,225.6	171.6	42	29.2	508.07	317.74	14.5	411.24	Loss	96.83
November, 1900..	3,909.6	91.8	46	28.4	520.88	350.17	31.0	493.17	Loss	27.71
December, 1900..	4,432.0	160.8	63	31.9	575.40	400.96	43.0	579.96	Gain	4.56
January, 1901....	4,829.6	97.8	63	29.3	575.54	433.42	49.0	630.42	Gain	54.88
February, 1901...	4,032.8	117.6	56	31.2	552.94	364.66	51.3	568.56	Gain	15.62
March, 1901.....	3,696.0	113.4	42	25.8	508.16	332.16	35.0	487.61	Loss	20.55
April, 1901.....	3,645		45	28.7	517.67	307.40	20.0	417.40	Loss	100.27

TABLE 5. DETAILED EXPENSES OF AN APARTMENT HOUSE (NO. 11) FOR EIGHT MONTHS.

In building No. 12, a large apartment house, the output of the plant was calculated from average ammeter readings procured from the chief engineer, and the expenses of operation were also obtained from him. The generators are in operation night and day, as there is no connection with the central-station mains and no gas is used. Besides its use in generating electricity, steam is employed for a refrigerating machine, for steam cooking apparatus, for a laundry, and for a large house pump. The results of recent tests to determine the coal used for these machines show a consumption of 978 tons per year, and since the total amount burned for all purposes for one year was 2,897 tons, the quantity chargeable to the electric plant and to heating is 1,919 tons. Of the employes, one man could be dispensed with were the refrigerating plant, etc., not installed, and his pay has, therefore, been deducted from the wages item in the list of expenses given in Table 4. The output of the plant and the probable expenses, were

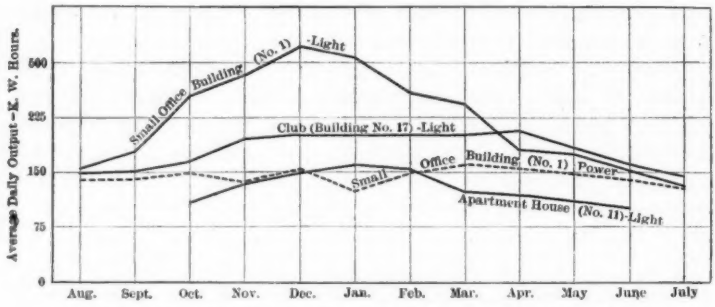


FIG. 10. VARIATION OF AVERAGE DAILY LOAD FROM MONTH TO MONTH.

current obtained from central station, are also given in the table and show the comparatively small gain of $1,670 for the isolated plant. This small gain is due mainly to the large coal item, which is 44 per cent. of the total expense of operation. The reason for the large amount of coal burned was found to be the bad condition of the boilers, which contained much scale and therefore evaporated less than five pounds of water from and at 212° per pound of coal. Were a normal amount water evaporated, such as 8.5 pounds per pound of coal, the coal item would be decreased by about $2,200 and the cost per kilowatt hour would be reduced to less than $0.045.

The statistics of these three apartment houses indicate that this class of buildings can be run at much less cost with the isolated plant than with the central-station service, provided the plant be properly installed and economically operated; but the gain by the plant is smaller than in the other classes of buildings we have considered, and great care must be exercised lest this gain be turned into a loss.

At a large apartment house ten stories in height and 100 by 100 feet in plan, having a large restaurant on the ground floor, hourly readings were taken of the amperes used for lighting but no records were kept of power output or of expenses. The curves of Figure 13 and the load curves for the apartment house in Figure 16 were plotted from

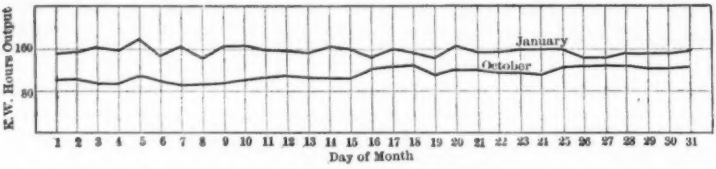


FIG. 11. VARIATION FROM DAY TO DAY OF THE LIGHTING LOAD IN A SMALL APARTMENT HOUSE (BUILDING NO. 11).

the above readings. The plant in this case supplies light for the entire building and power for four electric elevators, and consists of horizontal tubular boilers and three 75-kilowatt generators direct-connected to simple engines.

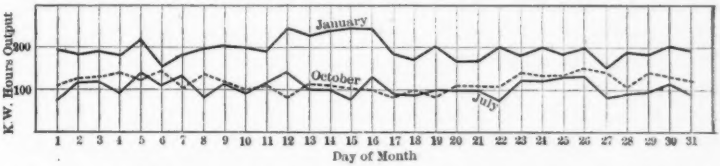


FIG. 12. VARIATION FROM DAY TO DAY OF THE LIGHTING LOAD IN A LARGE CLUB (BUILDING NO 17).

Concerning the economy of the isolated plant in hotels there is very little doubt, as is shown by the fact that nearly all the buildings of this class in New York, both large and small, have installed electric plants. The load in hotels is inherently favorable to the plant, as it is considerably more uniform than in apartment houses of the same size, on account of the large number of lights always burning in the restaurants, parlors, and halls, and the power load is continuous and heavy. Further, in almost all cases a steam plant is necessary to furnish steam for refrigerating machines and similar apparatus, whether current is generated on the premises or obtained from without, so that the extra expense entailed by the installation of the electric plant is small. The presence, however, of hydraulic elevators, refrigerating

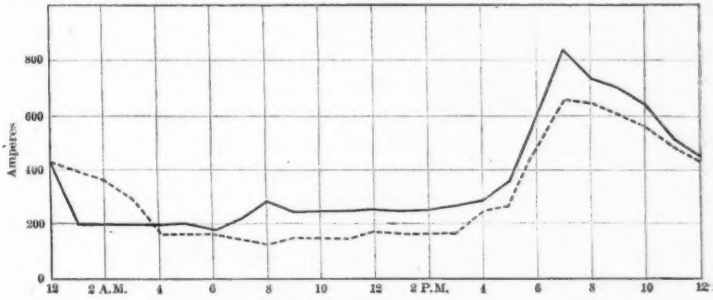


FIG. 13. MAXIMUM AND MINIMUM LIGHTING LOADS IN A LARGE APARTMENT HOUSE DURING MARCH AND APRIL.

machines, etc., though rendering the operation of the electric plant economical, made it impossible to obtain reliable figures excepting from very few hotels.

Building No. 13 is a hotel which shows excellently how little extra

expense is entailed in some cases by the installation of an electric plant. Before the generators were installed, two 125-horse-power boilers supplied steam for elevator pumps operating two hydraulic elevators, for a steam laundry, for steam cooking apparatus, for a 12-ton refrigerating machine, for a 10-horse-power blower engine, and for various other purposes. The electric plant furnishes current for lighting the two lower floors of the hotel only, the same boilers being used as before the installation of the dynamos. Accurate statistics of coal, labor, etc., were available, but the figures concerning kilowatts output are only approximate since no complete daily records are kept. The generators are run throughout the twenty-four hours and the load diagram is shown in Figure 14. The table shows the increase in the expenses for

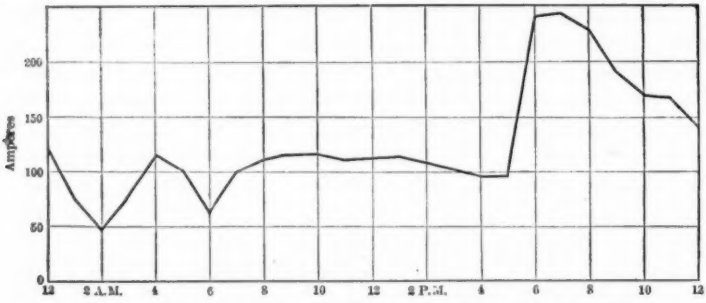


FIG. 14. LOAD CURVE OF A SMALL HOTEL (BUILDING NO. 13) FOR OCTOBER 9.

ten months due to the electric plant. The very small increase in the expense for coal is due to the fact that a cheaper grade of fuel was burned after the installation of the generators. One fireman was the only extra employee made necessary by their installation. The cost per kilowatt hour does not in this case include the expense of heating, and would be much larger if reduced to the same basis as the figures of the other plants; but it shows the extremely small cost of generating electricity under the conditions which prevail in this hotel.

In building No. 14, which is a small hotel, the output of the plant was calculated from hourly ammeter readings which were obtained from the chief engineer, and figures of the expenses of operation were procured from his books. The only machinery using steam besides the engines driving the dynamos and small feed and house pumps was apparatus for steam cooking, and the amount of coal burned due to this use of steam was approximately 150 tons per year. This quantity of coal, subtracted from the total coal consumption for all purposes of 1,976 tons, leaves 1,826 tons chargeable against the electric

plant. The expenses of running the plant and heating the building are given in Table 4 and compared with the probable expenses, if the central-station service were used, the installation of the electric plant brings about an annual saving of $5,100. So large an output in so small a building is accounted for by the large amount of electricity used for power and by the great number of lights always in use in the restaurant. Not only are two electric elevators run, but a 10-ton refrigerating machine, a brine pump, and several large ventilating fans are operated electrically, and since the ice machine, pump, and fans are in use twenty-four hours a day the load on the generators never falls below 250 amperes. These conditions enable the dynamos to be operated at loads giving high efficiency and help to bring about the low cost per kilowatt hour.

In a large hotel eight stories in height and about 60 by 160 feet in ground plan, where both electric and hydraulic elevators are operated, a dynamo was recently installed, a steam plant for the elevator pumps, etc., having already been in use several years. This dynamo carries a part of the lighting load. It was found during a month when this dynamo was shut down that the central-station bills for the current which the generator had formerly supplied were over 25 per cent. greater than the cost of operating that machine.

In Buffalo, where the conditions as to cost of coal, labor, etc., are not very different from those in New York, and where it would be supposed that the Niagara Falls Power Company could furnish current about as cheaply, compared with the isolated plant, as in any city in the United States, one of the large hotels operates a plant of its own This plant, which is run in conjunction with a large refrigerating machine, is not the most modern nor best of its kind, and yet it shows each year a substantial gain in economy over the central-station rates. From the above facts it seems, therefore, that in the hotel the conditions are perhaps more favorable to the isolated plant than in any other class of buildings.

We will now consider the clubs, the sixth and last class investigated.

The load in these buildings resembles most nearly that in apartment houses, although the elevator load is usually very much smaller and the lighting load is likely at times to attain a higher peak. On account of the very small load during the morning, many clubs take current from the central station during that part of the day instead of running the plant.

In building No. 15, a very small club, the output was calculated

from half-hourly ammeter readings taken by the engineer, and the cost of operating the plant was obtained from his records. Steam is used only for the engine driving the dynamo, for small house and feed pumps, and for heating. The 20-kilowatt dynamo is in operation from 4 P. M. to 1 A. M. only, and is run usually at about three-eighths of its capacity, though the maximum load may reach 150 amperes. When the generator is not in operation gas is used for lighting. There is no elevator in the building, so that current for lighting only is supplied. For the months from November to March inclusive in 1899-1900 and 1900-1901, the operating expenses and output of the plant will be found in the table, as well as the probable expenses were no plant installed. The figures show a saving, by the installation of the plant, of about one-third of the total cost of running the building if the central station supplied the current.

Building No. 16 is a large club. The output of the plant was calculated from ammeter readings furnished by the chief engineer and the expenses of operation were obtained from his records. Steam is used only for heating, for the electric plant, and for a small house pump. The plant is in operation from 5 A. M. until midnight, when the building is closed for the night. A potential regulator enables one generator to be used for both elevator and lights during the day, without any disagreeable fluctuations in the lights due to the large starting current when the elevator starts. Although the lighting load from 5 A. M. to 5 P. M. is but 25 amperes, it is necessary to run a large generator since the starting current of the elevator momentarily increases the load to 140 amperes. Since, however, the elevator is in actual motion less than one-seventh of the time, the current used by it has little effect in increasing the average load on the dynamo, which remains too small during the day for very efficient operation. Nevertheless a comparison of the expenses of running the building with and without the plant given in Table 4 shows a saving of nearly $4,000 yearly due to the installation of the plant.

Building No. 17 is another large club. The output of the plant was calculated from half-hourly ammeter readings, and the expenses were obtained from the chief engineer's books. The dynamos are started at about 4 P. M. and are run until 2 A. M., when the plant is shut down. During the time that the plant is not in operation, gas or current from the central station is used for lighting. The load on the generators averages about 75 per cent. of their capacity, and the load factor for the nine hours they are in operation varies from 0.79 to 0.95 according to the time of year, the load being unusually uniform as

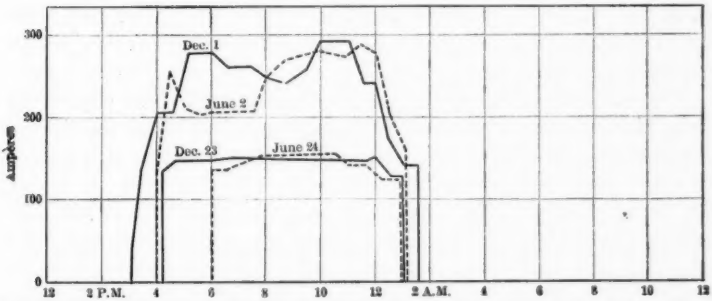


FIG. 15. MAXIMUM AND MINIMUM LIGHTING LOADS IN A LARGE CLUB (BUILDING NO. 17) DURING THE SUMMER AND WINTER MONTHS.

shown in Figure 15. Beside a small house pump, the feed pumps, and the engines driving the generators, steam is used for a small blower engine and for an elevator pump running an hydraulic elevator. This elevator is in operation very intermittently. The amount of coal used for the blower engine and pump is about 294 tons per year, and since the total coal consumption for one year was 780 tons, 486 tons are chargeable to the electric plant and to heating.

The expenses of operation and the output of the plant for one year are given in Table 4 and show a gain by the installation of the electric plant of $1,400 a year, an amount which would undoubtedly be much increased were it not that the boilers, engines, and generators are old-fashioned, having been installed over eleven years ago, and cannot give such high efficiency as a more modern installation.

The large amount of coal burned per kilowatt hour, which includes the coal used for heating, is partly due to the fact that the plant is in operation such a short time daily. There is thus no exhaust, except from the elevator pump, during the morning and early afternoon, and the building has to be heated partly by live steam, which of course results in the consumption of a considerable quantity of coal. The large central-station bill also increases the cost of production considerably. Thus the actual amount of current produce in the plant was 65,593 kilowatt hours at a total expense of $5,190, which makes the true cost of production $0.079 per kilowatt hour—somewhat less than the cost stated in the table. Figure 10 shows the variation from month to month of the average daily lighting load in this building, and Figure 12 indicates the change in load from day to day in January, July, and October. The figures on these three clubs indicate that even if the club is a very small one, or if the plant must operate under unfavorable condi-

tions, the installation of an electric plant will enable the building to be run at considerably less expense than were current taken from the central-station mains.

Figure 16 shows the variation of load as affected by the weather in six of the buildings which have been discussed, each of which is fairly characteristic of its class. The statistics of weather conditions were obtained from the United States Weather Bureau. The curves of Figure 17 show the relation between the total yearly output, on one hand, and the cost of production and the pounds of coal burned per kilowatt hour, on the other hand, in all of the seventeen buildings. The curves pass through many of the points, and the points which lie far outside the curves belong to buildings where peculiarly favorable or unfavorable conditions have been noted.

The statistics of the seventeen buildings which have been discussed in detail show, as a whole, the decided advantage of the isolated plant over the central-station service. It is rather curious, however, that it is usually in the smaller buildings that the greatest percentage of gain is found, this being due partly to the greater proportional saving brought about by heating the building with the exhaust, and partly to the fact that there is more relative difference between the central-station rates which the small building would pay and the cost of production in the isolated plant, than there is between the central-station rate the large building would pay and the cost of generation in its isolated plant. The small plant is, however, much more sensitive to unfavorable conditions of any kind. Though the central-station rate never reaches so low a point as the least cost per kilowatt hour in a very large isolated plant, the decrease as the amount of current increases is greater in the central-station rate than in the cost of production in the isolated plant.

By comparing the results in the different buildings the factors which influence the economy most seem to be:—

First:—The installation of the right number of generators with neither too large nor too small capacity, as a whole, thus avoiding injury from overload and reducing interest and depreciation to a minimum.

Second:—The installation of generators of such size that they may be operated, as nearly as possible, at full load. This is a consideration of great weight, as has been shown in the case of several of the buildings discussed. What the proper sizes are is, however, a somewhat difficult problem to solve, as in installing a plant in a new building the load conditions to be met are somewhat doubtful, and even in a build-

Large Apartment House Light
Large Club (No. 7) Light
Department Store (No. 9) Light
Small Office Building (No. 1) Light
Large Office Building (No. 3) Light
Large Loft Building (No. 6) Light and Power
Amperes
0 A.M. 12 6 P.M. 12

FIG. 16. VARIATION OF LOAD AS AFFECTED BY WEATHER. WEATHER CONDITIONS WERE OBTAINED FROM U. S. WEATHER BUREAU.

ing formerly lighted from the central station the installation of an isolated plant often so changes the conditions as to upset the most careful calculations.

Third:—Heating in the smaller buildings is a very important factor, and, in some cases, the current is produced for exactly the price at which it would be furnished by the central station, the only gain being the cost of heating. Could the central station supply steam at low rates along with electricity, the days of the isolated plant, in the smaller apartment houses and clubs and in many loft and office buildings, would be numbered. When the building is large, the amount which would be expended for heating, were no plant installed, is still gained; but it is a much smaller proportion of the total cost of running the building, and is relatively a less important factor.

Fourth:—The shape of the load diagram has a considerable influence on the economy, and the buildng with a high peak to its load must have machines which are used but little and whose cost increases the items of interest and depreciation considerably. The curves for the two office buildings shown in Figure 2* are examples of favorable and unfavorable load curves.

Fifth:—Where other machinery using steam is present beside the electric plant, a considerable reduction in the cost of labor may be brought about by combining the employees necessary for running the electric plant alone and those who would be necessary for the other machinery if no electric plant were installed.

Sixth:—The keeping of careful daily records of output, supplies, and expenses may have very important results in the way of economy If these records are inspected daily, or even weekly, by the agent in charge of the building or by the owner, they indicate at once, if properly kept, whether there has been laxity on the part of the employees or waste of supplies, and, even if the reports are handed in and never looked at, the fact that a record has to be made and that it is possible to ascertain by it the conditions prevailing in the plant has been found to exert a beneficial influence. Further, by comparing records of different weeks or months, the engineer can find whether his plant is working more or less economically, and in addition the results of any changes he may make in apparatus or management can be ascertained, approximately at least, from these same reports. Careful records also may lead to the discovery of the inefficiency of the boilers, the poor quality of coal, or wasteful use of current which might otherwise have remained unknown, but which is indicated in the records by extraordinary increase in the output or in the expense of operation.

* THE ENGINEERING MAGAZINE, January, 1902, page 579.

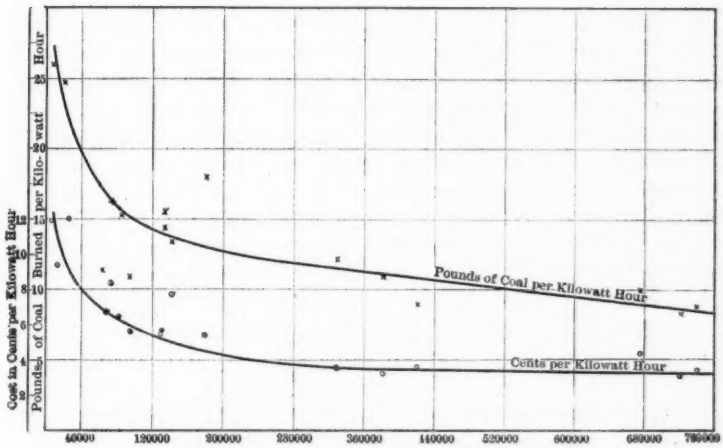


FIG. 17. TOTAL YEARLY OUTPUT. KILOWATT HOURS.

Seventh:—The character of the engineer was found in almost every case to be reflected in his plant, and his competency or incompetency exerts a most important influence on the economy of its operation.

Eighth:—The temperature and ventilation of the engine room or storage-battery room may be of consequence with respect to economy. Not only will dynamos operate more efficiently when placed where the temperature is not excessive, but any machinery in a room where the temperature reaches 140 degrees F. will not be taken care of properly by the engineeering force, whose only thought, naturally, is to finish their work as speedily as possible and get out into a cooler atmosphere. In one plant where the cost of installation did not exceed $9,000, $2,500 had to be expended in repairs during the second six months of operation. These repairs were made necessary simply by negleect on the part of the engineers, who avoided as much as possible any labor in the engine room where the thermometer stood at 140 degrees to 150 degrees F. In another building, a $20,000 storage battery depreciated in the first two years after its installation at least $8,000, from neglect caused by its being placed in a low ceilinged, unventilated room. The crowding together of the machinery may be undesirable from the point of view of convenience, but high engine-room temperature and poor ventilation seem to have far more unfavorable effects on the economy.

Ninth:—The amount of coal-storage capacity may have consider-

able influence on the cost of operation, for not only does large capacity enable coal to be bought by the boat load at a lower price per ton than if it were purchased in small lots, but in case of a severe snow storm or a strike of men connected with the handling of coal, it may save the plant from the necessity of shutting down and thus either depriving the tenants of light and elevator service and causing great dissatisfaction, or making it necessary to use, for a time, current from the central-station mains, for which high rates must be paid.

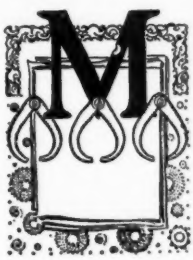
Tenth:—The type and number of elevators used, apart from their efficiency as elevators, affects the economy of operation. Of this the last two buildings Nos. 16 and 17 furnish examples. In building No. 16 an electric elevator is used and necessitates the operation of a large dynamo most of the day at an extremely light load, whereas were no elevator present, or were an hydraulic elevator used, a very small machine (4 kilowatt) could be employed, since the load is constant at 30 amperes; or this small amount of current could be taken from the central station at very little extra cost, as is the case in building No. 17. In this connection the potential regulator may play an important part, for without it or a storage battery, the operation of a lightly loaded dynamo, or even a heavily loaded one, for supplying both elevator and lights is practically impossible without extremely disagreeable fluctuation in the lights whenever the elevator starts. When several electric elevators are installed a separate machine can of course be run to supply the elevators alone and still operate at a fairly efficient average load; for the greater the number of elevators the more the resulting current will tend to be fairly uniform.

Eleventh:—The storage battery is one of the most important factors in the economy of the isolated plant, and it furnishes another means by which electric elevators can be run from the same dynamo as the lights and at the same time sudden fluctuations in voltage can be avoided. Further, when the storage battery is used the dynamo does not have to supply all the sudden rush of current as the elevator starts, and the battery enables the generators to be run at or near full load during most of the time the machines are in operation. In a building with a peaked load-diagram the battery can be used to carry the peak, thus avoiding the installation of little-used dynamos and engines and perhaps of an extra boiler. Again, by charging during the day and discharging at night, the outlay for labor may be much reduced, the use of central-station supply may be avoided, and opportunity given for repairs to all the engines and generators.

OPPORTUNITIES FOR IMPROVEMENT IN MICA MINING.

By George W. Colles.

The time was, not many years ago, when a few tons of mica would have glutted the market. Now, in consequence of the large and growing use of mica in the electrical manufacturing industry, its mining is becoming one of the important minor mineral industries. Rather curiously, this close relation to the most modern of developments has not yet lifted mica mining out of the crudities of old-fashioned and laborious methods of working. Mr. Colles' paper may serve to direct attention to the needs and the opportunities of a neglected corner of the mining field.—THE EDITORS.



ICA is peculiar among the infinitely varied products which civilization has called into requisition for general usefulness, in that it is well-known to all and yet its nature and manner of production are very little understood—so little, indeed, that it is often confused in the popular mind with the utterly different substance, "isinglass" (a corruption of the German *hausenblase*, —sturgeon-bladder) to which it bears a superficial resemblance. Nor, when its common occurrence is considered, is it readily apparent why it should sell in quantity at prices which rank its value by weight with those of the precious metals.

That mica is one of the most universal and common of the minerals that make up the earth's crust is a fact known not simply to geologists, but which may be observed by anyone, as its glassy lustre proclaims its presence in granite, gneiss, schists, and the like, and in some places the ground is literally covered with it. In these common rocks, its two usual associates are quartz and felspar, these three combining to make up the stone called granite. All three are products of terrestial heat, and are invariably formed where the proper constituents are present and the cooling takes place with sufficient slowness, and they are accordingly characteristic of metamorphic and igneous rocks. The coarseness of the rock thus formed bears a direct ratio to the rate of cooling, and only in the case of igneous rocks, i. e., where the material has been completely fused, are the individual crystals of mica, quartz, and felspar found in any considerable size, and then only when the

cooling has been with extreme slowness—has extended, we may suppose, over years, decades, or even centuries—so as to allow each crystal as it forms to grow by accretion, and the different minerals to crystallize in order as their respective points of solidification are reached.

Thus we arrive at the gigantic form of granite called pegmatite, in which most of the commercial mica is found, and which is still made up of mica, quartz, and felspar, but in crystals varying from the size of one's head up to that of a small house. But while in such igneous formations both quartz and felspar occur in mountain masses individually, mica is found only in comparatively small blocks or agglomerations of blocks, associated with other minerals. Not even all pegmatite contains mica; on the contrary, most pegmatite is made up of quartz and felspar only, and even when mica is present it occurs only with the greatest irregularity and uncertainty. The pegmatite occurs in what are known as "dikes," by the geologists, or by the miner less correctly as "veins." They are not true veins, however, but intersect the strata at all angles and in a very erratic fashion, running hither and thither, branching, suddenly widening or narrowing, and at times disappearing altogether, perhaps to recommence again in a nearly parallel vein a few feet further on. On the surface of the ground they are scarcely ever continuous for more than a few hundred feet.

But the mere finding of a pegmatite dike, even in the mica region, gives no necessary indication of the presence of that mineral. On the contrary, experience shows that in only a few regions of the earth occur dikes which contain mica in paying quantities, and even in these regions no certain indications of the presence of mica in a dike have yet been discovered. For the most expert miner, it is still substantially a mere guess whether paying mica is present or not. When present, there is often a distinct lead which the mica blocks follow, strung out along either the hanging or foot-wall of the dike, and in this case the excavations may be made through the somewhat softer country-rock instead of in the hard pegmatite. But this lead is often discontinuous, petering out into worthless trash or scrap; and it may, or may not, start afresh further on in remunerative quantities. Thus days may be lost in groping about for a new lead, and it has happened that the entire profits of a rich haul of mica have been consumed in this manner. Mines have been abandoned as exhausted, and yet when again worked by a subsequent owner have yielded plentiful returns. Nor are leads always present, for the mica often occurs bunched together in pockets, in great agglomerations of crystals, or even single crystals of large size.

The mica as it comes from the mines is in blocks which are theoretically short rhombic prisms, but practically are scarcely recognizable as such, having a very rough and uneven contour. They have a very perfect cleavage parallel to the base, and may be split into laminae thinner than the thinnest tissue paper, and these laminae form the familiar, transparent stove-panes and lamp chimneys. The exterior portions of these blocks are opaque, brittle, and worthless, presumably from the penetration of water, for mica soon decomposes when exposed to any considerable weathering. A thick layer of plates has therefore to be removed from either face of the block before any mica of commercial size or value is reached, and the sheets split from the remainder are surrounded by a wide margin of worthless material.

But the difficulties and losses of mica mining are far from being all enumerated. Even when occurring in blocks of commercial size, it is rendered valueless or comparatively so by one or more of a series of defects, which may be classed as: color, specks, ruling, ribbing, and wedge-formation. Color is a defect only for certain uses, as for stove glazing, and, in ground mica, for decorative purposes. The color of mica may be anything from black, dark-green, or wine-color, to yellow and pure white or, rather, colorless; the former kinds being useful principally for electric and the latter for glazing purposes. The color of mica is dependent on its composition, and both together are the main guides to its value, independently of other defects.

A great variety of minerals known to the geologist, all of more or less indefinite composition, are classed as mica. Physically, all have the well-known micaceous lustre and cleavage; and chemically, all are substantially compound silicates of aluminum and of some other base or bases, such as soda, potash, lithia, lime, magnesia, iron, manganese, etc. For present purposes, we may roughly classify the three main commercial varities as white or potash mica ("muscovite"); yellow or magnesia mica ("phlogopite"); and black or iron mica ("biotite"); but it is not to be understood that these form hard and fast lines, for they shade insensibly into each other. The last is much the commonest of the three, and indeed most colored micas owe their tints to iron, which is the all but universal coloring agent, and biotite is found in all colors between light yellow-green, smoky brown, and black. The potash mica is too hard and brittle for most electrical uses, but well adapted for glazing and flour. The yellow mica (which includes the "amber mica" of the trade) is fairly well adapted and much used for both purposes. The black mica is unavailable for glazing and flour, but is generally excellent for electric purposes, when not

marred by specks and streaks, to which it is peculiarly subject, and which absolutely destroy its usefulness. That which is most in repute for the last-named use, however, is a dark wine-colored or ruby variety from India, called by the trade name "India mica," though the color is not confined to India, and India produces other mica. The green micas, on the contrary are rather too hard for electrical uses and a bad color for glazing, as it happens that a greenish tinge sticks to them and is perceptible even in thin sheets; and again, it has been found unfortunately that when ground they give a flour deficient in lustre, so as to be unfitted for this purpose; they are therefore, of inferior value.

Coming now to the defects properly so called, that of specks and streaks is one to which biotite is peculiarly subject. It some times occurs literally pied with black dots, consisting in general of black oxide of iron or garnet, and when even a few of these are present its commercial value is destroyed, because such mica when used as an insulator is peculiarly liable to puncture, the specks forming practically short circuits for the electric current. The same is true of streaks, which are sometimes turned to red rust. Strange freaks in the arrangement of the streaks have been observed, as for instance where a block was half white and half black, the margins being sharply defined by a straight line running through the middle of each sheet; or again, where the streaks ran parallel to one or both edges of the block, marking off the sheets like a checkerboard. The causes for these strange formations, as well as for the following similar ones, are entirely problematic.

Some otherwise excellent mica is found to be ruled or cut, as it were, with a series of perfectly straight lines, parallel to one side of the crystal, so that on being split the mica falls immediately into strips. The defect may be confined to the sides of the block, or extend entirely across, and sometimes the block is "double-ruled" so as to break up into small lozenges. Such mica is of course perfectly good as scrap, though its value as sheet mica be destroyed. Or again, instead of being striped or ruled, the mica is often deeply ribbed or corrugated parallel to the adjacent edges of the crystal, so as to give the appearance of the letter A (or rather V) whence it is termed "A-mica." As the ribbed portion has to be cut away in sheet, such mica is also unprofitable, unless the blocks be large. Wedge-mica is that in which the block is thicker at one end than the other, the laminae partaking in the unevenness. Such blocks are wholly worthless except as scrap.

The reader will doubtless now begin to understand why mica is high-priced. It is not at all that it is a rare mineral, like gold, silver,

uranium, etc., but because of the hazards and uncertainties of mining it, and the extraordinary proportion of waste between the rough block and the finished product. But all is not yet told, for even after all else is allowed for, the somewhat irregular sheet of good material must be further diminished in size by cutting or trimming. Electric mica is now generally "thumb-trimmed," but nearly all mica mined in the United States for glazing purposes is still cut into rectangular shape before leaving the mine; and thus nearly one-half of the good portion goes to the scrap heap. Finally, if, as often happens, the square plates of cut mica are again cut up into other shapes, another large fraction of the material is wasted at the point of use.

Summing up the various sources of loss, it may be estimated (in the case of North Carolina) that the cut mica, as it reaches the market, is not more than one-thirtieth to one-one-hundredth part of the mica mined, and as a rule not more than one-five-thousandth to one-ten-thousandth part of the rock excavated.

Having thus obtained a general idea of the character of mica in its native state, let us glance briefly at the history of the industry before considering its present status in the United States. That mica was mined and utilized by the nations of antiquity for decorative and other purposes is a matter which need not here interest us. Of more importance is the fact that it was well-known to and highly prized by the prehistoric races of the Western continent, as it is evident from the finding of mica plates and ornaments in the tombs and mounds of the mound builders hundreds and perhaps thousands of miles from its place of origin,—if, as now supposed, all this mica was exported from a single centre in North Carolina. Here it was that, in 1869, under the shadow of Mount Mitchell (the highest point east of the Rockies), in exploring one of their mysterious ancient shafts in search of antiquities or what-not, their real object was rediscovered, and an archaeological problem was solved and a vast new source of wealth created at a single stroke. Previous to that time the entire supply of mica was drawn from southern New Hampshire, and a large part of the American product is still from that State.*

Upon the discovery of mica in North Carolina, however, a rush for lands ensued which paralleled on a small scale the gold fever of twenty years previous, and in fact even today the valuable mineral may be said to play the same part among the natives of Mitchell and Yancey

* The Ruggles mine at Grafton, which has been in continuous operation since 1803, has produced $8,000,000 worth of mica, and at one time produced four-fifths of the total requirement of the United States.

counties as gold does in the placer districts. The output quickly outstripped that of New Hampshire both in quality and quantity, and the leadership has been maintained, for North Carolina still produces about three-fourths of the country's output in value. For many years mica mining in North Carolina continued to be a very lucrative occupation, and mica lands changed hands at fabulous rates; but the decline of the 80's, and the increasing competition of foreign mica, brought the industry down to a more commonplace basis. At least a dozen other States have from time to time contributed in a small way to the American product of mica, but only two are of consequence, to wit, the Black Hills region of South Dakota and Wyoming, and the Cribbensville district of New Mexico; but even their contribution is trifling. Practically the whole American product continues to be mined in southern New Hampshire and the back counties of North Carolina, and must continue to be so until some new and better region shall be discovered. Until about twenty years ago these two States were substantially the mistresses, not simply of the native market, but of the world's as well, for Europe has no mica of her own. But in the early 80's two new countries—Canada and India—almost simultaneously appeared as producers, and their output has grown annually with such rapidity as, in the case of one of them at least, to overshadow and even to threaten the existence of the industry in the United States.

The Canada mica comes principally from Ottawa county in Quebec, though some is also mined in Perth and Renfrew counties in Ontario, and the mines are chiefly the outcome and legacy of the "phosphate boom" of the 80's, during which many valuable deposits of mica were discovered in the soft apatite. Here lies at least part of the secret of the cheapness of Canadian mica, for apatite is far more easily mined than the flinty matrices of the pegmatite dikes. The increasing demand of recent years for mica for electrical purposes has caused great development of the mines, modern machinery has been installed, and the production of Canada now equals in value and exceeds in quantity that of the United States. This mica is deficient in transparency and in size, but is considered very good for electrical purposes.

Mica has been mined and used in India from an indefinite period, but the development of the mines by Europeans has been contemporaneous with that of Canada and of the electrical industries. Until very recently the only source of Indian mica was in the province of Bengal, where very large and rich mines were discovered, centering mainly in the Hazaribagh district, where more than 6,000 men and an indefinite

number of women are employed. It is the ruby mica of this region that has made its reputation as "India mica" in the United States and Europe. Within the last four or five years, however, new districts have been opened up, in particular in the Bombay presidency and in the Nellore district of Madras, and these being nearer the coast are more favorably situated for export. Export from these regions has, in fact, grown with great rapidity. Enormous sheets are said to have been found at Nellore, one being reported as measuring five feet across.

The secret of the cheapness of the Indian mica and its threat to the western industry lies in four main advantages: the ease of working the mines, their richness in mica, the quality of the product, and the cheapness of labor. The ease of working lies in the fact that the rock matrix is so decayed that it is easily cut away, and the mica is so abundant that scarcely any of the mines are worked beyond a depth of 200 feet. The product is moreover considered better adapted for electrical purposes than other mica by reason of its softness and pliability. But the greatest advantage lies in the cheapness of native labor used in working, the men receiving but 3 annas* per day and the women half that amount. Yet there are disadvantages, too, as for instance the distance of the mines (35 to 70 miles) from rail transportation, and the climate, which makes the region untenable for Europeans during the rainy season, so that the mines can be worked only nine or ten months of the year; a further disadvantage is the small sizes of the Bengal mica.

The value of *sheet* mica produced annually by India is far in excess of that produced either by the United States or Canada, and the quantity would bear a still greater disproportion, and moreover the production is on the increase. By values we may reckon the production at the present time about as follows: India one-half, and the United States and Canada each about one-fourth. Of this world's production it is interesting to note that the United States consumes *more than one-half*, including all its own product, the bulk of that from Canada, and a large fraction of the Indian mica, the amounts of Canadian and Indian mica imported each being about equal to the home product. The remaining portion of the Indian mica goes almost all to England, and is there partially reshipped to Germany and France, the only other users of consequence.

* The anna is 1-16 of a rupee, and its equivalent in gold varies widely with the price of silver; at the present time, with the rupee equal to about 1 s. 4 d., 3 annas would be about 3 d. or 6 cents.

In considering the status and prospect of the mica industry the uses of mica form a very important element. The two principal uses of mica are, as previously mentioned, in the stove and lamp trade, and in the electrical field. Prior to 1880, the former was substantially its sole use, and owing to the great decrease in the use of stoves in recent years, caused by the introduction of improved methods of heating, both the demand for and the value of mica experienced a rapid decline. By the beginning of the last decade, and especially during the years of commercial depression, owing partly to this cause and partly to the great increase in imports, the industry had become almost extinct in the United States; but since 1895 it has more than regained the lost ground. The causes for this sudden revival are two: the new use for mica, now far more important than the old one ever was—as an electric insulator; and the appearance of a new branch of the mica industry—the manufacture of mica flour.

To those unfamiliar with the matters under discussion, two questions will here present themselves, to wit: Why is mica of such importance as an insulator? and, what *is* mica flour? Let us consider each of these briefly and in order.

Mica is or may be employed in almost all forms of electrical apparatus, being one of the best insulators known, and in practical all-round use perhaps the very best. In resistance to the electric current and to puncture by spark it is about equal to glass, and stands therefore nearly at the head of the list, while its toughness, flexibility, infusibility, and perfect impregnability to moisture (all qualities of great importance in an insulator), and the extremely thin leaves in which it may be obtained, make it absolutely without a rival for the purposes for which it is used. While suitable for almost all kinds of electrical work, it finds its chief use in the commutators of dynamos and motors, in which service it has no substitute; and as all direct-current machinery must have commutators, and the use of such machinery is constantly on the increase, it can be seen that the increasing use of mica is inevitable. Its high price has naturally caused a substitute to be much sought after, but none has been found, and it seems unlikely that any will be found, animal and vegetable products being all barred by their susceptibility to heat. Enormous quantities of small electric forms, such as commutator segments for fan-motors, washers, small plates for the interior of cut-out boxes and fuse-plugs, and the like, are now punched from what was heretofore considered scrap mica and was substantially valueless. Other waste pieces of mica are cemented by shellac into large sheets of uniform thickness, called "micanite,"—

also used to some extent for commutators,—or pressed into the forms of tubes for covering armature wires or other irregular shapes.

But another important industry has arisen almost simultaneously with the electrical industry—that of mica flour. In 1870 a patent was issued to Frederick Beck for a process of coating wall-paper and other surfaces with a mixture of ground mica and transparent varnish. When so applied to surfaces mica has a silvery lustre and sparkle which is not simply equal to that of metal, but has the vast additional advantage that its lustre can never fade or tarnish with age, as all metals must do sooner or later. Moreover, the great cheapness of the mica powder or flour compared with that of metal dust caused it to supersede the latter entirely as an ingredient in wall-paper colors, processes for gilding and coloring it having been invented. At the present time almost all of the cheaper wall-papers are decorated with large quantities of mica paints, while the finely tinted grades are used even in the higher-priced papers. Yet while mica flour has been a staple commodity in the market since about 1890, it is only within the past five years that the great development has taken place, the production of mica flour rising from less than 600 tons in 1896 to 7,000 tons in 1899. The value of scrap mica rose from nothing to $17 per ton. and as many of the mines had large dumps of scrap mica, they were able to realize considerable sums by its sale. The production of scrap mica increased, and in New Hampshire many mica mines were operated for scrap alone, so that the price of scrap soon fell again to about $6 or $7 a ton, where it still is. But the flour industry continues to grow, though still confined wholly to the United States.

From the above brief review, it may be surmised that though encouraged by the two new sources of demand for mica products, now on the increase, the American mica industry is so threatened from without by foreign competition that its future stability is seriously in doubt; and this surmise is in part correct. It is only a formidable protective tariff (amounting practically to prohibition as to scrap and flour mica), one may say, that prevents its extinction; take that away, and it would be immediately swamped by the flood of foreign imports; for how can the United States compete with the pauper labor of Asia, paid at six cents a day? Such a conclusion, however, is apt to be erroneous, as has often been found in the case of other industries, and as a more thorough knowledge of the conditions well shows in this case also.

The fact of the matter is that the whole rich mining region of North Carolina has been strangely overlooked by northern capital, and

the spirit of enterprise which has swept over the country during the last five years and brought it such unparalleled prosperity has passed that section undeservedly by. There the crude unlettered mountaineer still goes forth with hand-bit and hammer to "hog" the mine, it may be, for a royalty of 15 or 20 per cent. to the owner; or at best, a dozen join together in their slow and painful operations of drilling and blasting, a rough screen-reel is constructed for freeing the mica from dirt, and the blocks are split by hand and cut one by one with a pair of shears and a templet in a neighboring shed; in short, mica mining in North Carolina is exactly where it was thirty years ago. The backwoodsman has intelligence, but nothing like enterprise; his labors are limited to the needs of the day and hour. The streams still glide over the gleaming crags unharnessed; the timber forests remained unused.

It is useless to say that the power drill cannot be advantageously applied to mica mining; that has too much the air of the philosophers who proved the earth was flat, that heavy bodies fall faster than light ones, etc. Experience of the New Hampshire operators as well as of the Canada mines has proved the contrary, and in each case the introduction of power has been followed by a large increase of output.

There is room for immense improvement and development in the mica region by a judicious expenditure of capital. There need be no fears of North Carolina being unable to hold her own against either India or Canada, for the simple reason that she has a superior grade of mica, and all that it is needed is economical methods of production. She has both first quality and large sizes, and that is a boast which neither Canada nor India, nor any other region in general, can boast. She is within easy reach of all the great mica markets; she too has plenty of cheap, but intelligent labor; she can mine for sheet and scrap simultaneously; and she has abundant water powers in the immediate mining district, and coal not far distant. When as much money and brains have been employed in introducing modern methods there as have been employed in New England, it will be found that the North Carolina mica has no more to fear from India mica than the New England and Lancashire cotton mills have to fear from the Indian spindle and distaff; and this is no doubt true to some extent of New Hampshire also.

AIDS IN TAKING THE MACHINE-SHOP INVENTORY.

By Hugo Diemer.

IN an establishment of sufficient magnitude to justify the employment of a full and capable clerical force to handle the cost and stores department, stock-taking is not as formidable a matter as in smaller concerns; but in many manufacturing establishments, the taking of an inventory is looked forward to as the most onerous task of the year. It is frequently months after the date on which the work is begun before the final results are announced.

In factories where systems of cost and stores accounting are used similar in principle to the excellent methods described by the late J. Slater Lewis in his comprehensive work,* it is feasible to have the books closed and inventories taken as often as monthly. The question of how extensive a factory must be in order to justify the employment of such a full clerical force is naturally one which depends upon the complexity of the manufacturing processes and also upon the margin of profit. It is, however, true, that the complete cost analysis revealed by a full clerical force may in itself be the very means of increasing the margin of profit. I had occasion to be shown the cost and stores systems of a factory whose output amounted to about $250,000 of annual sales. The number of persons doing clerical work in the establishment amounted to about 10 per cent. numerically of the entire working force of the company, and it is fair to assume that their salaries represented an equal percentage of the total wages expenditure. At first sight this clerical force seemed disproportionately large. Yet I was assured by officials of the company that since the introduction of this system they were able to adjust their prices with a feeling of confidence that they had never before possessed. The books are closed and a complete report of the company's business is rendered to the directors on the 10th of each month for all business done during the preceding month. The company has been able to meet the prices of all competitors, to maintain a high degree of mechanical excellence, and to declare a monthly dividend of 1 per cent. for more than two

* The Commercial Organisation of the Factory.

years. The successful application of a complete cost and stores system to an establishment of this size, employing only about one hundred men, has strengthened my conviction that a more general adoption of these methods in smaller factories will surely come, and will be accompanied by more general industrial satisfaction on the part of both employers and employed.

There are, however, many factories that are not quite prepared to go so fully, or, as they would put it "plunge so deeply" into shop-accounting systems. But with even an office force of minimum size the matter of inventory taking may be simplified by the use of properly arranged card systems.

In general the inventory may be divided into three broad headings:

1:—Plant.

2:—Stores.

3:—Finished and Partially Finished Product.

The items coming under the heading of Plant, if properly recorded, can be inventoried in a very short time. Under this heading will be included Real Estate, Buildings, Power-Generating Apparatus, Transmission Apparatus, Piping, Wiring, Fixtures, Machinery, Contents of Tool Room, Patterns and Drawings.

It is advisable to keep a separate card on which to keep record of each single item included in the above sub-divisions with the exception of Contents of Tool Room, Transmission Apparatus (Shafts, Belts, Pulleys, etc.), Piping and Wiring. A card suitable for those Plant items which will have a distinct card for their record is shown below.

Item No. *125.* Name *Universal Milling Machine.*
Size No *1½.* Location *Section "A."*
No on Article *29.* Date Purchased *6/25/99.*
From *E. S. & E. Co.* Cost *$650.00.*

Date.	Last Inventory Value.	Repairs.			Depreciation.		Present Inventory Value.
		Date.	Nature.	Amount.	Per cent.	Amount.	
Jan. 1. 1900	*650.00*	.....	.....	.....	*10% 6 m.*	*32 50*	*617.50*
Jan. 1. 1901	*617.50*	.....	.....	.....	*" 1 yr*	*61 75*	*555.75*
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....

FIGURE I. INVENTORY CARD FOR PLANT ITEMS.

The number in the upper left-hand corner of the card after the words "Item No." is merely the number of the card itself, and is

inserted in order that an alphabetical index may be kept. Thus in the alphabetical index we will find under "M" "Milling Machines—Cards Nos. 126, 228, 329." The fixing of the location of the article and the number painted or stamped upon it are further identifying checks. Where the factory is divided into "Sections," the letter or number of the section is usually sufficient to locate the piece.

The proper percentage of depreciation to be used is a matter which has been discussed at length by various writers. Experiments have been made to determine the average life of various items. It is evident, however, that the length of life and rapidity of deterioration of machinery and transmission apparatus will vary widely. Where trustworthy data, based upon a number of years of observation, are not at hand, it has been customary to allow a general depreciation of 10 per cent. per annum on all machinery. On belting and transmission apparatus in general a slightly larger depreciation is sometimes charged, varying according to the service. Buildings kept in good repair are often charged with a very low percentage of depreciation.

Figure 2 shows a form of card suitable for the record of articles of which there is a considerable number of one kind, and which do not require individual record, such as small tools, shafting, etc.

Item No. *327.* Name *Flat Bastard Files.*
Size *8″* Location *Drawer 89. Tool Room.*

No. on Hand.	Value.	No. Added.	Cost.	Repairs.		Depreciation. .... %	Present Inventory Value.
				Date.	Amount.		

FIGURE 2. INVENTORY CARD FOR SMALL ARTICLES.

It is very similar to the card shown in Figure 1, but will necessarily be a longer card, requiring a deeper cabinet for its filing, because of the frequent additions necessary during the year. For the small items covered by the card of Figure 2, it is best to be more

explicit as to location. In the example given the drawer number in the tool room is stated. In the case of transmission apparatus we might say "East side of Section B", or some similar brief location. The record of small tools may be further refined by stamping numbers on files, cutting tools, etc., and recording each small tool individually on the large card of Figure 2. This system has been applied to the shops of a technical college and may possibly be found useful in some factories. It will be seen that all the cards of form shown in Figures 1 and 2 can be easily kept figured up to date, and that consequently items coming under the general heading "Plant" can be very easily inventoried at any time.

The real value of patterns and drawings as an asset is a matter in regard to which there is considerable difference of opinion. Special drawings and patterns are charged to the particular order for which they are made, and these cannot be considered of any value excepting as scrap. On the other hand, standard patterns and drawings have a real value which should be subject to a considerable depreciation. Where the value of standard drawings and patterns is not calculated for each piece, but all work on such standard patterns and drawings is charged to a standing order number, the total cost of all new standard patterns and drawings for the year is given by the standing order, and this total added to the properly depreciated value of the previous year gives the current value. This method of course does not assign a definite price to each individual pattern and drawing. Where record is kept of the cost of individual drawings and patterns, distinct cards for each piece may be used similar to the forms shown. These forms will be useful in recording the proper location of patterns in racks, and additional columns may be added showing how often and on what orders the standard patterns and drawings have been used.

Referring to the second general subdivision, namely Stores, all systems of mathematical record need to be checked annually by an actual count. If this checking up is all done at one time, the store keeper should be furnished additional help at that time. A form of card which enables the store keeper to see at once the number of pieces of any article he has on hand and the number he needs for orders in hand is shown in Figure 3. If the checking up by actual count, to verify the amount on hand as shown by the cards, is practiced continuously, the card records are available for inventory-taking at very short notice. The valuing of goods is facilitated by having on hand lists of standard screws, etc., with the prevalent net price per hundred inserted in ink in the printed lists. Such lists accompanied

Item No *625*. Name *Hex. Hd. Cap Screws.*
Size *⅜" x 2"*. Location *Drawer 267, Store Room "A."*

1. On Hand at Last Count.	2. Received.		3. (1 + 2)	4. Needed for Orders.*		5. Excess or Shortage. (3—4)	6. Drawn on Orders.		7. On Hand. (3—7)
	Date.	No.		Order No.	No. Req'd		Order No. and Date.	No Drawn	
10/1 321	*10/20/1901*	*00*	*421*	*Brot for'd*	*212*	.....	*B621 10/23*	*48*	.....
.....	.....	....	....	~~*B 621*~~	~~*48*~~	.....	*C273 10/45*	*32*	.....
.....	.....	....	....	*C 273*	*64*	.....	*B622 10/27*	*12*	.....
.....	.....	....	....	*B 622*	*24*	.....	.....	.....	.....
321	.....	*100*	*421*	.....	*300*	*121*	.....	*92*	*329*
11/1 329	.....	...	...	*Brot for'd*	*300*	.....	.....	.....	.....
.....	.....	...	...	.....	.....	.....	.....	.....	.....
.....	.....	...	...	.....	.....	.....	.....	.....	.....
.....	.....	....	...	.....	.....	.....	.....	.....	.....
.....	.....	..	...	.....	.....	.....	.....	.....	.....
.....	.....	....	..	.....	.....	.....	.....	.....	.....
.....	.....	..	.....	.....	.....	.....	.....	.....	.....

* NOTE.—As orders are completed they are cancelled in Column 4. When card is balanced a li e is ruled across the card and balance as shown in Column 7 is transferred to Column 1.

FIGURE 3. CARD FOR STORES ON HAND AND NEEDED FOR ORDERS.

by a slide rule will be found to be time-saving devices. A judicious use of the slide rule would relieve cost work of a great deal of drudgery, but there is a wide-spread feeling regarding its use which is best expressed by the following remark made by a shop foreman concerning one of the engineering staff: "He's one of them 'slide-rule' fellers—too technical to be practical". Not wishing to fall in his estimation I did not apprise him of the fact that I made daily use of the simple little instrument in cost-department work.

It is apparent at once that in a store room containing from five to ten thousand items it will be about all that one competent clerk can do to enter daily from bills of material of new orders the number of items required for orders, and to check off on the cards the number of items drawn. The preparation of several thousand cards is in itself no small task. The officials of a company have been known to acquiesce willingly in the erection of proper racks and drawers in a store room, and to employ willingly more "store-room boys," but to hesitate when confronted by the expense of a card accounting system. The case is perfectly analogous to that of an inefficient power plant whose inefficiency is not apparent on account of lack of engineering instruments and engineering ability, where, instead of raising the

efficiency of the system by bettering it, more generating apparatus of equally low efficiency is added, thus continuing the loss on a larger scale. The principles of good engineering find opportunity for their application in the store room as well as in the power plant and designing room.

Stationery and printed matter will be included under the heading of Stores. A system for recording stationery forms and costs consists of stout envelopes bearing the numbers of the forms, copies of the forms themselves being kept inside the envelopes. The dates of ordering, amounts ordered, the name of the printer, and the prices paid, are recorded on the envelope. The envelopes are then put into cases such as are ordinarily used for the filing of vouchers or documents. With the aid of this index, which is kept in the purchasing department, stationery and printed matter can be quickly inventoried. It is just to consider forms in current use as worth what they cost. The intrinsic value of catalogues and printed matter may be almost a negligible quantity when compared to their cost. In establishing inventory values, however, the sane view (and that most generally taken) is to consider the value of goods as what they would be worth to a company engaging in the same business on the same premises, and not the figures that articles would bring if sold at a forced sale. For this reason it is customary to attach a value to factory fixtures, special tools, and foundations, as these are all essentially part of the plant.

The accuracy of the inventory prices attached to the third general division, namely Finished and Unfinished Parts, depends upon the cost-calculating system employed. It might appear that a good way to obtain approximately the cost of unfinished parts would be to close up to a certain date all time-and-material records on all unfinished orders. As a rule, such a procedure would interfere very greatly with the continuousness of work by the time and cost clerks. A far more satisfactory way is to build up costs of individual parts, preserving them on cards arranged according to pattern numbers. With these costs as precedents, values of unfinished parts can be closely approximated.

The introduction of card systems similar to those suggested, and the employment of a few really competent clerks to handle the cost and stores systems, will make the monthly closing of factory accounts possible even in comparatively small establishments, and in most cases the advantages gained will more than compensate for the expense entailed.

EDITORIAL COMMENT

THE Isthmian Canal remains easily the most important material question before the commercial world—for it is of world importance, and of foremost importance to the great maritime nations almost in direct proportion to their merchant tonnage. One of the curious phases of the matter is that shipping interests have taken so little apparent part in the debate, for the most important question of all is, what will be the actual service of the completed waterway to the sea carrying trade? If the Nicaragua Canal when finished will be so difficult of navigation, so menaced with risk of accident or delay, so embarassed by the necessity of contant maintenance and repair operations, that insurance and pilotage rates become burdensome, and masters refuse to attempt the passage under any ordinary conditions, the world will be no better for the enormous expenditure and the United States will be millions the worse in pocket and immeasurably humiliated in influence and prestige. Glory to the United States does not lie in the flag fluttering over the canal, but in the commerce streaming safely through it. And that shipping would ever take freely to the Nicaragua Canal, completed as planned or on any plans which are possible to the route, we do not believe. The long stretches of canal section and canalised river, the difficult and relatively sharp curvature, the extension of the time of semi-dangerous navigation to so long a period as thirty-three hours, would inevitably shut out a great proportion of the possible patronage and would hamper the remainder so far as greatly to diminish the benefits of the canal. The route could not hope to compete for any traffic which could be alternatively routed via Suez, nor for any which could afford the time of passage via the Straits of Magellan.

* * *

It is most extraordinary that the disputants, so far as they appreciate or acknowledge at all that any economic considerations are involved, seem to think of nothing but the elements of construction, whereas the whole question of construction is entirely minor to questions of operation, maintenance, and above all, utilisation. Mr. Charles Paine, writing in THE ENGINEERING MAGAZINE in February, 1900, laid down the proposition that the serviceableness of any ship canal is inversely as the square of its length. Mr. George S. Morison, whom engineers generally will doubtless regard as by far the safest engineering authority on the Walker Commission, expresses practically the same conclusion, stating that the projected Nicaragua line, involving 2.3 times the length of steaming in actual canal sections which would be required by the Panama route, would carry five times the risk of detention, even supposing (which is extremely far from being the case) that navigation would be as easy by the Nicaragua Canal as it would be by the Panama. The greater ease, safety, and celerity of the Panama passage would make that route preferable if it cost double as much to construct as the Nicaragua. And while prophecy is a very uncertain avocation, we venture the prediction that if the Nicaragua scheme be unfortunately adopted, the United States will be making further and further appropriations for it long after double the money has been expended which would

complete the Panama line. But to return to our point: the shipping interests, to whom it is infinitely more important that a canal should be navigable than that it should have been projected, surveyed, and dug wholly by American engineers, should make their influence felt. Campaigning for education is slow, particularly among politicians, but it does make some progress. The 102 congressmen who were willing to allow the President to negotiate for Panama as well as for Nicaragua, represent an element of saving sense which may yet protect their country from the most "un-American" of all acts—the building of a bungling, inefficient, unserviceable tool.

* * *

MR. GEORGE A. SOPER, in the *Medical News*, discusses in a most interesting way certain aspects of the Isthmian Canal construction problem which, prior to the appearance of his article, had been curiously neglected. These are the sanitary conditions which must be dealt with both during construction and (again more important) throughout the operation of any canal across the Isthmus.

Mr. Soper notes the curious circumstances that, notwithstanding the radical influence which the question of liability to disease has upon the problem of labour—the greatest problem of all in the actual construction work—less than a page and a half of the Walker Commission's 263-page report is devoted to hygiene. This is hardly more space than General Abbot gave to the topic in his short but powerful article in this Magazine last month.

It is possible only to refer very briefly to Mr. Soper's most important conclusions, which are ably sustained by a thorough comparative review of the climatic and hygienic conditions, so far as they are known, along the two routes.

These conclusions are: that both routes pass through a country which is extremely unfavourable to health, the rainfall conditions in Nicaragua making it distinctly the more sickly region; that soil, topography, and the nature of the work to be done favour Panama, as the employment of fewer men in more concentrated organisation would reduce the number of lives exposed and make protection easier; after construction, the difficulty of controlling health conditions along the line would be greater on the Nicaragua route, and the longer time needed for transit would expose passing vessels to nearly three times as great a risk of infection; the likelihood of the canal becoming a disease focus, (thus interfering with commerce by requiring quarantine at healthy ports against vessels using the canal) is much greater in the case of Nicaragua than in the case of Panama; lastly, whichever canal is selected, extraordinary care will be needed to maintain satisfactory health conditions during construction *and afterwards*, and plans for an efficient sanitary and medical department can not be made too soon.

* * *

MR. SIEBERT, reviewing our editorial introduction of his leader in this number, expresses his preference for a slight change in the second paragraph. In the summary of his own views, he would say "the general manager of most modern enterprises can not be successful without a certain amount of technical knowledge."

We gladly give place to Mr. Siebert's own phrasing of the concept here, for the underlying idea, we are sure, is identical in his mind and in ours. The word "engineer," however, Mr. Siebert doubtless understands in its strict Continental usage—as defining a certificated member of a distinct profession. We used it in the broader English sense of a man possessed of knowledge of a particular branch of technics—that is, engineering practice.

REVIEW OF THE BRITISH PRESS

Legislation and Electrical Progress.

THE address of Mr. Percy Sellon before the Chamber of Commerce, published in the *Electrical Review* contains a very significant opinion as to the cause of the lack of progress of electrical development in Great Britain. As Mr. Sellon points out, there is every reason why Great Britain should have held the lead in the practical applications of electricity to which her pre-eminence in original research entitled her. The work of Faraday, Tyndall, and Joule, followed by the brilliant inventions and discoveries of Cooke, Wheatstone, and Thomson gave her a lead which other nations should have found it hard to overcome. Great Britain's free trade, her unparalleled manufacturing facilities, capital resources, and control of the world's markets all formed abundant reasons for the maintenance of her supremacy in this as in other branches of industry.

Instead of this possible high position in the electrical industry, we find that other countries have passed Great Britain in the race, and that at present she is in the position of gazing at her competitors and wondering why they have distanced her. As Mr. Sellon says: "We are both absolutely and relatively to the other leading communities of the world in serious arrear of the position to which we should have attained, having regard to the commercial traditions, free institutions, and highly organised industrial equipment of which we were the heirs when, less than a quarter of a century ago, the great developments of electrical science in the fields of telephony, lighting, traction, and power distribution, passed from the purely experimental stage into practical potentialities.

Various causes have been advanced to account for the present state of affairs. Among these are the early reckless speculation in electrical affairs, the commercial expansion of Germany and the United States, the unfavourable home labour conditions, and the general apathy of engineers and manufacturers. Nearly all of these causes however, have been at work in other countries as well, and without any such blighting effect as is claimed for them at home. Mr. Sellon examines each one of these points in detail and while admitting some of the effects attributed, he shows that they are entirely inadequate to explain the observed results so far as Great Britain is concerned. To maintain that the electrical progress in Great Britain is in arrear because the British electrical engineer is behind his rivals, is to reverse cause and effect, since the backward state of the electrical industry and of the electrical manufacturer are due to one and the same prime cause.

This prime cause, as Mr. Sellon clearly shows, is the fact that the legislature has applied to electrical science the principles of common ownership which, during the latter half of the last century have established an increasing hold on men's minds in England.

That there are certain functions of an industrial and engineering nature which properly devolve upon the municipality, every one will admit. Thus the protection of life and order, the maintenance and improvement of highways, the provision of open spaces for recreation, the control of education, provision for water supply and for sanitation, these and similar duties are most properly placed in the control of the municipality.

In 1870 the state bought out all the private telegraph interests for £10,000,000, and set up as monopolists in the art of transmitting intelligence by electrical means, and when the telephone appeared in 1877 the state laid violent hands upon it, with the result of making Great Britain the worst served country in the matter of telephony of any great industrial state. The Tramways Act of 1870 and the Electric Lighting Act of 1882 settled the maxim of industrial legislation that the community should

have an option of expropriating any public enterprise after a certain term of years without a burdensome addition in respect of good will and compensation for prospective profits.

The result has indeed been an enormous acceleration in the pace of municipal enterprise, but this has not been attended with the development of British industries which would have followed the encouragement of individual operations. The whole question is well stated by Mr. Sellon when he says:

"It is a question of profound national importance whether the alluring end of common ownership with all its promises may not be too dearly bought at the cost of the extinction, inevitable, if gradual, of private enterprise; whether gigantic systems of local self-government with their accompaniment of petty officialdom controlling all matters of daily existence will make life better worth living for the majority than a social structure founded on greater liberty and reward of individual effort; whether this country's past industrial supremacy can be better maintained, in the light of the conditions of acute external competition which have arisen and are becoming yearly more severe, by increasingly transferring the mainsprings of its operation from individual to corporate activity; whether socio-industrial progress can be better achieved under the auspices of necessarily inelastic and inexpert organisations such as corporate bodies acting as trustees of others' funds, than by expert administration stimulated by the hope of personal gain."

Electric Traction on Railways.

It was to be expected that the inaugural address of Mr. W. E. Langdon before the Institution of Electrical Engineers would deal largely with the question of the application of electric traction to main-line railways, and this expectation was not disappointed.

That electric traction is generally bound to come, Mr. Langdon fully believes, and considered without regard to existing methods and conditions, few will differ from him. When, however, existing conditions are taken into consideration, the obstacles appear to be great.

"Every line of railway has its own mode of dealing with its traffic, and the character of the traffic is not the same on all lines. The only satisfactory way to prove the power of electricity to meet existing conditions is to impose upon it the work to be done. To do so on a suitably selected section of line would not be a great tax upon the resources of any one of our great railway companies, especially as it need not in any way, for the time being, derange the steam-worked traffic passing over that section of line.

"Now let us look at the subject from another point of view. Electricity is credited with the power of accomplishing greater speed at a less cost than steam. An impression is abroad that greater facilities for rapid transit between large centres of commerce are a necessity of the day. If it should transpire that electrical propulsion is inapplicable to main line traffic as a whole—a conclusion which few would, even at the present moment, accept—it will unquestionably lead to the establishment between the chief commercial centres, of high speed passenger electric traction on independent lines. Communication between Manchester and Liverpool has, so far, been met—and one would say, amply so—by three lines of railway, all running a good train service, yet the construction of an electric line on the mono-rail system has received Parliamentary sanction.

"Nothing could be more disastrous than that competition of such a character as, for instance, that thus initiated between Liverpool and Manchester should arise. Whatever success may attend competitive electrical enterprise in this respect must be, to some extent, prejudicial to the established systems. If the former should prove a pecuniary success, the reverse must be the condition of the latter. The capital invested in existing railways exceeds thirteen hundred million pounds. The wholesale depreciation of such a vast sum, the interest of which forms the income of numerous families and annuitants, would be little short of a national calamity. Naturally, were independent electric lines of railway to be established between the chief centres of commerce it would still leave a large mileage of the existing lines of railway unaffected by them, but is it from those parts of a railway system that the earnings come? The consequence must be, at the least, a decreased

dividend, and probably in the end an enforced establishment on the older lines of a similar electric service between large towns.

"The work of the railway engineer is to construct railways; and if the opportunity arises he will not be deterred from doing so by any consideration of the injury his work may inflict upon existing interests. The way to prevent him from doing so is to make it clear that there is no profitable need for any such addition; and this can only be accomplished by the existing systems showing that they are prepared to avail themselves of the same means—to afford as far as possible the same facilities and advantages as are to be derived from independent electrically worked lines.

"Railways have to face the fact that electricity as a motive power is before them. That if it is not applied to the existing systems—if they do not elect to avail themselves of it, it will come independently, and in competition with existing interests.

"To attempt to approach the subject in a piecemeal fashion by dealing with a branch line here or there may be of service, but it can scarcely affect the main issue. While a small branch line is being converted, new lines between important centres will be constructed, and the passenger traffic between those centres will at least be split between the old and the new service. No one doubts the ability to apply electrical energy to branch lines, but many will doubt whether the traffic of a branch line can be so regulated as to form a continuous and remunerative service throughout the day. With main lines there can be no doubt of a regular demand, while most branch lines can with convenience be dealt with from the main line power station. Manifestly, however, if the trunk lines are eventually to be operated electrically, whatever may be done in relation to branch lines should be done with a view to harmonise with that system which will be ultimately employed on the main lines. I do not presume to indicate what that system may be—whether alternating or direct current—but it is clear that for main lines an overhead electrical service is inadmissible; and equally, to my mind, is a rigid or semi-rigid rate of speed. With a line carrying one class of traffic this latter question may not be so important, but on lines carrying a mixed traffic this cannot be so, for the power to vary the speed is a factor which must have an important bearing upon the working of the line. The speed, subject to a maximum limit, must be in the hands of the driver."

The preceding considerations bring up an economic problem which, while not new on a smaller scale, is doubtless destined to become more and more important and correspondingly difficult of treatment.

Are existing industries and investments to act as a bar to the development of new methods simply because of the upheaval which the change would cause? The advent of steam railways destroyed the stage-coach business, and small as this was compared with the present railway interests, the principle involved is the same. Because an industry has remained undisturbed in the possession of a certain field for many years does it thereby acquire a monopoly which is to bar all progress in rival methods of a new and revolutionary nature? There has been some discussion as to the position which the capital account of a business should hold, some contending that it is an asset, others that it is a liability, while others more frankly, and probably more correctly, have regarded it in the nature of a gambling stake. In private affairs a man risks his capital in a business enterprise, fully aware that some rival invention or new discovery may render the venture worthless, and there appears to be no good reason why the same rule should not hold in the case of corporations or in great aggregates of corporations. Already such a point has been raised in connection with the possible conflict between wireless telegraphy across the Atlantic in competition with the interests of submarine cable companies, and while this is a more or less remote rivalry, the interests involved are enormous.

The question bears a striking similarity to that of the depreciation and scrapping of obsolete machinery, which while in good working order can no longer be profitably used in competition with more modern devices. It will not do to assume that a plant can be carried along as a full representation of the invested capital merely by keeping it in good working condition on the basis on which it was erected and equipped. If it is not kept thoroughly up to date it is a most deceptive asset. The same is true of an in-

dustry based upon engineering operations.

It is practically safe to assume that sooner or later it will be entirely superseded, and that it should not only earn a profit on the original investment, but that it should also provide a sinking fund for the redemption of the original capital, or for the replacement of the old plant by the new. Such replacements are coming more frequently than the most radical have dreamed in the past, and that too upon an enormously increased scale, while the peaceful commercial solution of the problem is by no means in sight.

The War Office Motor Trials.

More than two years ago comment was editorially made in these columns upon the vast advantage which would have followed the use of motor vehicles instead of mules for hauling artillery and supply trains in South Africa. Since then the War Office has decided to investigate the subject, the matter having been placed in the hands of a committee on mechanical transport, and the results may be productive of successful applications. From a review of the work of this committee in several recent issues of *Engineering* we make some abstracts showing the progress which has thus far been made:

In order to obtain practical and trustworthy information upon the subject, it was decided to secure the assistance of the manufacturers of self-propelled vehicles, and with that view it was decided to offer three fairly substantial prizes for "the three self-propelled lorries which shall be adjudged, after a series of trials to be carried out by the War Office Committee on Mechanical Transport, to be the best suited for military requirements.

Eleven entries were made in response to the fully detailed set of official regulations which had been issued last summer, but of these only five actually took part in the trials, and of these but one was propelled by an internal combustion motor, that of Messrs. G. F. Milnes & Co., the others, by Messrs. Edwin Foden, Sons & Co., Straker Steam Vehicle Company, and by the Thornycroft Steam Wagon Company, all being propelled by steam.

The detailed description of the several machines may be found in the reports of the trials referred to above. All the steam vehicles were provided with compound engines, the Foden vehicle being equipped with a horizontal multitubular boiler, while the Straker and the Thornycroft vehicles were provided with water-tube boilers. The vehicle by Milnes & Co. was practically a Daimler lorry, provided with a four-cylinder hydrocarbon engine of the Daimler type, and furnished with the Cannstatt system of transmission gearing. One of the Thornycroft vehicles was equipped with a winding drum and 100 yards of wire rope, for use either in pulling itself out of a hole or for extricating its trailer in case of need.

According to the requirements the net load was to be 5 tons, of which 3 tons was to be carried on the lorry itself and 2 tons on a trailer, these weights being exclusive of fuel and water, all of which must be carried on the lorry.

The requirements for military service are naturally different from those demanded for commercial service. Thus speed is of secondary importance, much more weight being attached to the ability to traverse rough and difficult ground, while the distance which can be covered with the fuel and water carried is naturally most important. With these requirements must be united great strength and substantial construction to insure freedom from breakdowns, while at the same time excessive weight is objectionable.

The trials, while severe, were none too much so when it is considered that the vehicles would certainly have to meet similar conditions in military service. On the road, of course there was little or no difficulty, even on steep hills, and in the brake tests there was every evidence that the designers had met the requirements very fully. On the rough country tests, however, the real conditions of a campaign became more apparent, and the difficulties began to appear. The Foden vehicle, which had made a most excellent showing, came to grief in a ditch, while the Thornycroft, after successfully traversing some very soft ground, and also hauling its trailer up an ascent by use of the winding drum, finally had to be extricated by the aid of a convenient traction engine.

The trials revealed a number of weak points about the engines, details which will doubtless be remedied after these trying

experiences, but altogether the results of the trials were rather encouraging. It was hardly to be expected that vehicles designed primarily for commercial road service should meet fully to requirements for military transport, and the wonder is that they did so well as they did.

In summing up, we can hardly do better than quote from the report in *Engineering*, since it will probably be some time before the official reports are made public. Our contemporary says:

"Until the reports of the official observers—two of whom were on each vehicle—are made public, it would be premature to enter into details of the various competitions; for it is obvious that a considerable number of observers would be needed to keep all the wagons under observation during the many days over which the trials extended. It may, however, be safely said that the various tests have shown pretty conclusively that a self-propelled motor can be produced which would be of great use during the ordinary work of a campaign. Perhaps the Foden vehicle showed to most advantage on average roads. It made, on the whole, the best speeds on the long runs; though extra speed, we believe, is not considered, by the military authorities, a very important feature for these wagons after a certain moderate rate of travel has been attained. The low consumption of water and fuel which is reported of the Foden wagon may have been due either to the locomotive type of boiler, or to her feed-heater device, which also enabled a certain amount of exhaust steam to be condensed and recovered to use over again. We believe a filter was fitted to intercept grease. The chimney gases of the Foden boiler were of a lower temperature than those of some of the competing vehicles to judge by the state of the paint, and also from the fact that the exhaust was delivered from the chimney in very visable clouds, whilst the exhaust steam of other wagons was apparently superheated, as it was quite invisible.

"Thornycroft 'No. 6' is practically the standard pattern of the Thornycroft Steam Wagon Company's vehicle of this type. Thornycroft 'No. 7' was disappointing, considering the great things that had been expected of it. But it must be remembered it was entirely a new design, and the makers had not had an opportunity of trying it previously to correct the many little defects in detail that are sure to arise with experimental work. There was one feature about it which should prove to be a distinct success. That was the winding arrangement by which the power of the main engines can be utilised for pulling the vehicle out of a bog. The way in which the wheels of a traction engine will revolve in one place, merely sinking further and further into soft ground—excavating, in fact, a hole in which to bury the vehicle—is well known to many who have had such an unfortunate experience. Although the traction engine had to be called into use on the last day's trials, it is quite possible, had the ground been a little firmer, 'No. 7' might have wound itself out without assistance.

"So far as the respective advantages of the vehicles for military purposes are concerned, only military men can judge, and the awards of the committee of officers will be looked forward to with interest. It is to be hoped the full report will be made public."

Range Finders.

THE Spanish-American war showed the necessity for some more satisfactory and reliable method of measuring range distances than was there available, and hence the paper of Professor George Forbes before the Society of Arts, printed in the *Journal* of the society, is of interest, discussing, as it does the principles upon which such instruments are necessarily based.

As Professor Forbes says, all methods of optically measuring the distance of an inaccessible object depend upon using a base of known length, measured either on the ground or else as a part of the instrument. For measurements on land a long base may be chosen and a theodolite or similar accurate instrument placed at the ends and very precise results obtained. For use in warfare, however, the instrument must contain all within itself, be capable of giving direct readings without computation, and be light and portable.

The conditions permit the use of only a short base, but with care in design and construction there is no reason why excellent results may not be obtained. The foundation of the present improved instruments

is one by Adie, which consisted essentially of a base bar 36 inches long with four mirrors at 45 to the base, and a telescope in which two superposed pictures are seen, one picture being produced by reflection from the mirrors at one end of the base, the other picture from the other end. When the mirrors are parallel the images are seen double, but by slightly moving one of the mirrors they may be made to coincide, and the angle through which the mirror must be moved tells the distance.

This instrument was bulky and heavy, and the slightest variation in adjustment introduced serious errors, but it has been improved by Professor Forbes, and as made for him by Zeiss, of Jena, it has been converted into an instrument of precision. Double-reflecting prisms are substituted for the mirrors, the angle of reflection thus being made constant regardless of the exact position of the prism. The telescope is replaced by a binocular, and the measurements are made by a micrometer screw moving a wire in the focal plane of the binocular. There are two wires in the two tubes of the binocular, and by moving one of the wires until the two are seen as one while the object is also seen distinctly, the distance can be read within a limit of 2 per cent. of the truth.

Professor Forbes gives some interesting details of the construction of his instrument, which is shortly to be tried in South Africa, and if it meets with approval in the difficult conditions existing there it will be welcomed in military, naval, and exploring circles everywhere.

The Spontaneous Combustion of Coal.

In an interesting letter delivered at the Royal Service Institution, and published in the *Colliery Guardian*, Commander W. J. Caborne presented the latest views upon the subject of the spontaneous combustion of coal on board ships and the importance of the subject is such that some abstracts from the paper and the discussion upon it will be found useful. It is most desirable that proper precautions be taken to prevent the occurrence of spontaneous combustion, but such precautions can only be intelligently taken when the cause of the combustion is known.

Coal naturally absorbs oxygen from the air, and undergoes a process of slow combustion. As the process goes on heat is developed, and the temperature of the coal tends to rise. The activity with which oxygen is absorbed increases as the temperature rises. It appears, therefore, that the conditions necessary for the spontaneous heating of coal are a sufficient supply of oxygen, prevention of the escape of the heat generated. These two conditions are more or less incompatible. Whether the coal heats or not depends on whether the heat can or cannot escape as fast as it is generated. Since heat passes away more rapidly (other things being equal) the hotter the coal, while the supply of air for promoting combustion is conditioned by other circumstances, it often happens that the temperature of a heap of coal will rise to a certain point which it will not pass. If a heap of coal is prevented from coming in contact with the air no action will occur, and no heat will be developed. On the other hand, if the air supply be so free as to carry away the heat generated at a sufficient rate again no heating will take place. In order that spontaneous combustion may occur the supply of air must be nicely regulated. The kind of ventilation which used formerly to be employed with coal cargoes often supplied just the air necessary for spontaneous heating. At low temperatures the absorption of oxygen by coal is a comparatively slow process, and at a given temperature the rate of absorption depends on the ratio of the surface of the coal to its volume. Thus, other things being equal, the smaller the coal the more rapidly it will absorb oxygen. On the other hand, the coal cannot absorb oxygen unless the oxygen is there to be absorbed, and when the coal is in very fine dust the rate at which the air can penetrate the heap is only small. It therefore appears that when the coal is in large pieces it will only absorb oxygen slowly, because of the comparatively restricted area of surface which it exposes, while if the coal is in very fine powder the air will not be able to penetrate the mass with sufficient freedom. There is a general impression that coal is more likely to take fire spontaneously when moist than when dry, but the investigations of the New South Wales Commission, made in 1896, appear to show that moisture has no effect in promoting spontaneous combus-

tion. A far more important point is the initial temperature of the coal, and its protection from the hot surfaces of the engine and boiler rooms. The rate of absorption of oxygen increases so greatly with a rise of temperature that the moderate warming of coal by a steam pipe or boiler may enormously shorten the time necessary for spontaneous combustion to set it, or may render it possible in cases where it could otherwise not occur.

The size of a heap of coal also has an important influence on the liability to spontaneous combustion. The experiments of Mr. Fayol showed that under certain circumstances a coal never took fire by exposure to the air when the heaps were less than 2 metres high, no matter what the lateral dimensions of the heap might be. The general theory of the spontaneous combustion of coal may then be thus stated:

Coal always absorbs oxygen from the air, and always generates heat in consequence of the combination of the oxygen with the carbonaceous contents of the coal. The rise of temperature, however, which accompanies this process is dependent on the rate at which oxygen is absorbed on the one hand and on the rate at which heat escapes on the other. Both of these factors may be greatly influenced by comparatively trifling variations in the conditions. The size of the coal, the distribution of coal dust, the initial temperature of the coal, the temperature of the enclosure in which the coal is placed, the size of the heap of coal—all have an effect on the temperature attained. To anyone approaching the subject for the first time the great puzzle is to understand why some cargoes fire and why others escape—all being under conditions which are identical. After a study of the phenomena, however, it easily appears that there must necessarily be a kind of critical temperature. If the coal succeeds in reaching this then its thermal equilibrium becomes unstable and the temperature rises indefinitely. A very slight difference in the conditions will determine whether this critical temperature, which itself depends on special circumstances, is attained or not. The puzzle above referred to is therefore solved by the remark that when some cargoes fire and others do not the conditions are not the same in reality, though, roughly speaking, they may appear to be so. The apparently erratic behaviour of coal cargoes is therefore just what would be expected, having in view the fact that very slight variations in the circumstances may make all the difference in determining whether the critical temperature will be passed or not.

The precautions to be taken for the prevention of spontaneous combustion, then, are these three: to avoid piling the coal too deep; to avoid shipping the coal at all hot, or in contact with hot surfaces; and to avoid ventilation, or the free introduction of air.

The use of sulphur dioxide, generated by burning sulphur in air, delivered to the bunkers by a blower, is advocated as a means for extinguishing fires in coal bunkers, and it is believed to be superior to either carbonic-acid gas or to nitrogen.

The Nature of Explosions.

ALTHOUGH explosives have been used for hundreds of years in the form of gunpowder, and for more than half a century in the form of the so-called "high explosives," the theory of their action is not even yet fully understood. A recent lecture by Professor Dixon, of Owens College, Manchester, upon the nature of explosives, published in the *Colliery Guardian*, gives the latest theories upon the subject, and contains much interesting matter.

The earliest, and for a long time the only explosive, gunpowder, consists of two combustible substances, sulphur and charcoal, mixed with a third substance, saltpetre, which supplies the oxygen, permitting very rapid combustion without the presence of air. In such a mixture the particles lie side by side, and the oxygen is supplied to the combustible particles from without. Since 1832, however, explosives of other kinds have been made, explosives in which the oxygen is enclosed in the structure of the body with which it is burned. This more intimate relation between the combustible and the supply of oxygen, greatly increases the rapidity of the combustion, with corresponding increase of the explosive effect.

Although gases are not directly used as explosives, it is by the action of gases that explosive effects are produced, and it is by the study of gases that our knowledge of

explosives has mainly been obtained. Priestley, soon after the discovery of oxygen, experimented with mixtures of oxygen and hydrogen, and exploded them, forming water. It was in 1832 that the study of high explosives began, and in 1845 Schönbein produced gun-cotton, although it was not until 1865 that Abel showed that it could be rendered stable and reliable. Nitro-glycerine, discovered by Sobrero, in 1846, was introduced as an explosive by Nobel in 1863, and in 1866 he hit upon the idea of absorbing it in infusorial earth, producing dynamite, which was nothing but a solid solution of nitro-glycerine, and being solid could more readily be carried about. By dissolving gun-cotton in nitro-glycerine the explosive action is modified, being made less sudden, and therefore more available for use in ordnance. From modifications of this mixture is derived the smokeless ordnance explosive, cordite.

Leaving the subject of explosives themselves Professor Dixon proceeded to discuss the nature of the explosion itself. The investigations of Bunsen, many years ago, led to his statements of the velocity of propagation of explosions in gases, namely that the propagation in oxygen and hydrogen was about 36 to 40 yards a second, and the propagation was slower in a denser medium. The later work of Berthelot and of Le Chatelier, however, has caused the figures of Bunsen to be greatly modified. According to their experiments an explosion in a mixture of hydrogen and oxygen travelled at an increased rate from the point of inflammation until in a very short time the rate became constant. Berthelot calls this rapid explosion the "explosion wave." The rate of explosion is a physical constant for each explosive mixture. It is independent of the diameter of the tube, and only slightly affected by the pressure on the gases. Professor Dixon's own experiments confirm and extend those of Berthelot. The rate of explosion is equal to the mean rate of movement of the burning gases at the temperature of the explosion, calculated according to the "molecular theory." Le Chatelier had shown that the flame began by travelling slowly at a uniform rate, that it then commenced to oscillate violently, and, finally, either the explosion wave was set up or the flame died down. There are thus three *régimes* of explosions —first, the uniform and slow combustion; second, the vibratory period; and third, the explosion wave. Mixtures of coal gas with air and firedamp with air show phenomena of the first and second kind. Ignited at the open end of the tube these mixtures burn at a uniform rate for a certain distance, and then the flame begins to vibrate. The vibrations acquire greater or less velocity according to the nature of the mixture and the conditions of the experiment, but the third *régime* of uniform maximum velocity is not set up. In narrow tubes the explosion soon dies out. The phenomena studied by Le Chatelier have been observed in a large scale in explosions in coalmines. It had been noticed that little damage was caused at the source of the explosion, and at a distance varying from 50 to 80 yards from the origin of the flame, while beyond that distance falls of roof, broken tubs, and blown-out stoppings testified to the violence exerted by the explosion. Great as the destruction is which an explosion of firedamp and air causes in a mine, it is fortunate that these mixtures do not detonate. The physical nature of detonation has thus been explained by experiments on gases, but other problems still remain. The mode in which chemical atoms unite, the dissociation of compounds, the variations in specific heat, are all subjects of extreme interest on which we may hope for more light from a study of explosions. It appears that M. Berthelot by an entirely different series of experiments has come to the same conclusion that Professor Dixon had previously come to—namely that gases explode with very great rapidity when the flame is allowed to run down a long tube or gallery. M. Berthelot, however, should have the credit of being first to publish his results, and he showed that the explosion rate of hydrogen and oxygen, instead of being 40 yards a second, is more like 3,000 yards a second, and other gases such as firedamp, mixed with oxygen explode at the rate of between 1,000 and 2,000 yards per second, and that consequently not only the rate of explosion but the pressure between these explosions is enormously greater than those imagined by the older experimenters such as Bunsen.

Steam Turbine Tests.

EVER since the earliest introduction of steam as a source of motive power attempts have been made to devise a successful and economical rotary engine, but such attempts have failed until the recent introduction of the steam turbine. Even yet there are many who fail to see how it is possible for a wheel which is blown around by the force of a steam jet to equal in economy an engine made with a packed piston operating in a bored cylinder. Actual tests, however, are more convincing than pre-conceived ideas, and hence it is desirable that the results of reliable trials should be widely discussed.

An interesting series of such trials is described in a paper in *Zeitschrift des Vereines deutscher Ingenieure,* by Herr Schmidt, some abstracts from which are given.

The cause of the trials was an altogether practical one, and hence the tests differ from those performed in an engineering laboratory. It was required to install new motive power in an old engine room, and the limitations of space made it desirable to use De Lavel steam turbines if a satisfactory performance could be obtained.

Since it is impossible to take diagrams from a steam turbine, there can be no indicated power, and the trials were based entirely upon the effective power, this being obtained from the current developed in the driven dynamos, or measured by a friction brake. The steam consumption was computed from the known discharging capacity of the nozzles, and also measured from the weight delivered to the condenser, the theoretical and experimental values agreeing within 1/10 of 1 per cent. The turbines, two in number, were of 100 h. p. each, the steam pressure 172 pounds per square inch, and the steam saturated. The boilers were fitted with a Hering superheater, but owing to losses in the piping and steam drum, the temperature of the steam at the throttle was only that due to the pressure.

Without going into the details of the trials, the steam consumption, for a run of 4½ hours, was 8.16 kilogrammes per effective horse power, or almost exactly 18 pounds. This included the steam required to drive the condenser pump, which is properly chargeable to the main engines; but deducting the steam required for the pump, the consumption for the main engines was 7.69 kilogrammes (16.92 pounds) per horse power. These results, to be comparable with those of cylinder engines, should be corrected by an amount representing the mechanical efficiency of the reciprocating engine, this varying with the type of engine, but ranging from 80 to 90 per cent. Making a deduction of 10 per cent. to reduce the above results to that of highly efficient steam engines it will be seen that the steam turbine is quite as efficient a machine as the reciprocating engine of the same power.

It has been pointed out that the steam turbine is especially well adapted for use with superheated steam, since there are no rubbing surfaces, no valves to keep tight, and no lubricants to become carbonized by the heat. In experiments made by Herr E. Lewicki at the Technical High School at Dresden, upon a non-condensing De Laval turbine of 30 horse power, the consumption by using steam superheated 336 degrees C., was 11.5 kilogrammes per h. p. hour, while with saturated steam it was 17.7 kilogrammes, an economy of 30 per cent. The higher temp rature of discharge of the exhaust steam makes it desirable to employ it for heating the feed water.

An interesting feature of these tests at Dresden, is the observed fact that the resistance of the empty turbine is less in superheated steam than in air or in saturated steam. By driving the turbine by an electric motor it appeared that the resistance of the wheel was 1.3 h. p. less in saturated steam than in air, and with a superheating of 300 degrees C. this resistance

was further diminished between 2 and 3 h. p. Further researches in this direction re in progress.

Herr Lewicki develops formulas for the steam consumption of steam for turbines of the De Laval type, based upon the steam pressure, the cross section of the nozzles and the specific volume of the steam, the constants being varied for saturated and superheated steam.

The steam turbine appears to be destined to improvement along the lines indicated by Herr Lewicki, namely, by an increase in mechanical efficiency, by the use of highly superheated steam, and by the use of the heat remaining in the exhaust in a regenerator.

Radiant Energy.

We have noticed in these columns already (July, 1901) the remarkable discoveries of Becquerel, the Curies, and Debierne, in the field of radio-activity of certain metals, especially uranium, polonium, and most of all the new metal radium, and now we note further interesting phenomena in papers presented by the same investigators before the French Academy, and published in *Comptes Rendus.*

The emission of rays of energy has been observed in but a limited number of elements thus far, but it has been found that a similar action may be induced in substances which of themselves are not active. Thus such inactive materials as copper, platinum, tin, glass, paper, etc., become radio-active when enclosed in a vessel together with a solid radiant salt of barium, and the same effect is found with solutions of salts of radium. This activity appears to be independent of the pressure or of the nature of the gas contained in the enclosed vessel. Some interesting phenomena may be thus produced. Thus there are certain substances which become phosphorescent when exposed to rays of light, and these substances also become luminous when placed within the range of activity of radio-active substances. Zinc sulphide, for example, is phosphorescent after exposure to the rays of bright light. If now two glass bulbs be connected by a double bent neck, and in one bulb there is placed a radio-active salt of barium containing a few milligrammes of radium, and a small quantity of zinc sulphide be placed in the other bulb, and the whole hermetically sealed, the zinc sulphide will become briliantly phosphorescent under the influence of the rays emitted by the radio-active materials in the first bulb, although these latter substances themselves emit no light. This luminosity is due to the activity communicated through the tube, and not by the direct rays emitted through the glass bulb. If a non-phosphorescent substance, such as copper, be placed in the second bulb, it will not become luminous, but it will instead emit rays which are, so to speak, induced by the action of the radiant substance in the first bulb.

A similar example of radio-inductivity is found with glass, the phosphorescent Thuringian glass becoming especially luminous. This induced activity appears to be depend essentially upon the free space existing between the two bodies. When the substances are placed very close together, say 1 millimetre distant, the radiant activity is weak, but when they are separated by about 3 centimetres, an active effect is produced.

The radio-activity, all other things being equal, appears to depend upon the quantity of radium introduced into the solution. For solutions containing the same proportion of radium the activity varies with the quantity of solution present, and in this respect it is not analogous to vapor tension.

These new developments in the domain of radiant energy may appear to belong, like those which preceded them, to the field of the physicist rather than of the engineer, but the laboratory physics of one decade becomes the applied engineering science of the next, and it is hard to draw any definite boundary line limiting the scope of either. Watt himself ascribed his practical development of the steam engine almost entirely to the lectures of Dr. Black upon the subject of latent heat, and the researches of Faraday and the theories of Maxwell form the basis of great manufacturing corporations to-day. When we admit that the apparently inexhaustible rays of energy from a chemical solution are capable of maintaining luminosity in an adjoining vessel for an indefinite period, we surely have a fact which is as probable to be of engineering value as the deflected floating needle of Oersted or the quivering frog leg on the laboratory table of Volta.

Sulphate of Lime in Feed Water.

We have already referred to the experiment of M. Boyer-Guillon upon the solubility of sulphate of lime in water at various temperatures, and their important bearing upon the question of the purification of boiler feed water. Now we have in the *Revue de Mécanique* a further paper by M. Boyer-Guillon detailing his experiments at length, and in view of the interest of the subject a brief reference is here made.

Sulphate of lime is well known to form a very hard and stubborn scale in steam boilers and its removal from feed water has always been desired. Carbonate of lime is readily precipitated by heat, being almost completely thrown down by heating the feed water to the boiling point so that with a large feed-water heater, with ample heating surface and space and time given for settlement, the carbonate may be removed by the temperature attainable with exhaust steam.

The temperature at which sulphate of lime is precipitated has been variously stated by different authors, the general idea being that about 300° F. (149° C.) corresponding to about 67 pounds pressure, absolute, all the sulphate of lime is precipitated.

The experiments of M. Boyer-Guillon, however, show that entire insolubility is not reached even at 200° C., and also that the time element enters into the question to an extent which should be taken into account in practice.

M. Boyer-Guillon approached the subject in a true scientific manner, by investigating, first the cause of the change in solubility of sulphate of lime by heat, and secondly the temperature or temperatures at which the action took place. A study of the chemistry of the subject showed that the sulphate originally exists in water in the hydrated form, containing two equivalents of water, and that by heat this is first converted into a hydrate containing half an equivalent of water, and finally appears in the anhydrous form.

Professor Van t' Hoff has stated that the first transformation occurs at 107° C., and this is sustained by the results of the present experiments, since the curve plotted from the results shows a sudden jog or change of direction at that temperature, and from that point the solubility diminishes more rapidly. The transformation into anhydride, however, appears to be more gradual, and does not reveal any critical temperature in the curve.

The apparatus used in the experiments is described and illustrated in full detail in the paper. The method consisted in preparing a standardized solution of sulphate of lime in distilled water, in heating it to a recorded and uniformly maintained temperature, and in filtering it at this temperature, the precipitate being subsequently weighed. The care which was given to all the details of the work certainly render these researches far superior in point of precision and accuracy to any which have heretofore been made. The precipitates were carefully analysed, the apparatus thoroughly calibrated, and the results may be accepted as reliable and trustworthy.

In general these results are stated as follows: The solubility of sulphate of lime in water increases from 0° to 34° C., at which point the maximum is reached. From thence it slowly diminishes until a temperature of 107° is reached, this being the point of transformation from a sulphate of 2HO to a sulphate of ½HO. The solubility then decreases more rapidly, although the rate is not uniformly maintained, until at 200° the solubility reaches 0.15 grammes per litre, or 0.015 per cent.

These valuable experiments should have an important bearing upon the design of apparatus for the purification of feed water for steam boilers. By far the greater portion of the scale in land boilers is formed from the deposit of suspended matter, mud, clay, etc., and from the precipitation of carbonate and sulphate of lime. The suspended matter may nearly all be removed by providing time and space for settlement, together with reasonable care for removal of the sediment from the purifier. The carbonate of lime may be precipitated by heating the water to the boiling point, which may be accomplished by the exhaust steam. The above researches show that practically all the sulphate of lime may be removed by heating to 200° C., corresponding to a pressure of about 250 pounds. This is not readily attained in an ordinary heater, but it is possible that in some form of special economiser the heat of the waste gases might be employed for this purpose, and practically pure water delivered to the boiler.

ROUTE OF M. SANTOS-DUMONT FROM ST. CLOUD

Dirigible Balloons.

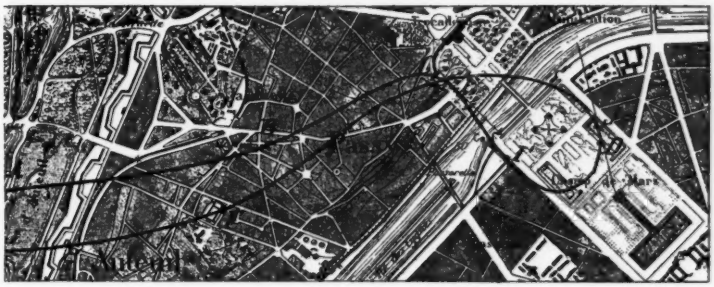
THE successful attempt of M. Santos-Dumont to win the Deutsch prize by making the trip from the Parc d'Aérostation at Saint-Cloud to the Eiffel Tower and return in 29 minutes, 30 seconds, has naturally attracted much attention to the subject of dirigible balloons and we find in recent issues of *Comptes Rendus,* various papers contributed to the French Academy upon the more scientific features of the subject.

It is naturally a matter of much importance to be able to plot upon a map the true path of a balloon, and M. Armengaud Jeune has developed a graphical method applicable to the problem. The path of a balloon is necessarily more or less waving, both in a horizontal and a vertical plane, but in every case a portion of a curved path may be replaced by the corresponding osculatory circle with a radius equal to the mean radius of curvature of the portion under consideration. Since the apparent velocity of the balloon is the resultant of its own velocity and that of the wind, it is necessary to determine these two elements within reasonble limits; or, if one element is given and the actual speed is observed, the other element may be computed. Now in certain portions of a complete trip such as that under consideration, the observed velocity is equal to the actual velocity, while at other portions the wind acts either to assist or to retard the velocity of the balloon. M. Armengaud shows how to construct diagrams based upon the theory of instantaneous centres of motion, as indicated above, so that the portion of the path in which the observed velocity of the balloon equals the real velocity may be detected. Assuming this velocity to be constant, the influence of the wind during the other portions of the trip may be computed, and by observing the times of the passage over known points, all the elements for the computation of the entire path are obtained.

M. Armengaud has plotted the path of the successful trial of M. Santos-Dumont of October 19, 1901, upon the military map of that portion of Paris included in the trial, and his diagram is reproduced herewith as an interesting record. The scale of the map is equal to 1:32,700. In his paper M. Armengaud gives the details of the observations for the data upon which the plan is based, the whole making a very interesting record of a memorable occasion.

The question of the determination of the actual velocity of the balloon is also discussed in a paper in the *Comptes Rendus,* by M. H. Deslandres, who gives equations for the determination, the velocity of the wind being noted. His results, which agree substantially with those of M. Armengaud, or about 8.5 metres per second, (a little more than three miles an hour) show a notable advance in speed over the results of the trials of Renard and Krebs in 1884, and of the brothers Renard in 1885, when the maximum speed attained was 6.5 metres.

Much of the progress exhibited in these recent experiments is due to the development of light and powerful motors. In 1885 the motor used weighed 50 kilogrammes per horse power developed, while at the present time the weight is but 5 kilogrammes, or for the same weight, ten times the power may be developed. Since the speed of the balloon is proportional to the cube root of the power, this should result in more than double the speed.



TO THE EIFFEL TOWER—PARIS, OCTOBER 19, 1901.

The two balloons of 1885 and 1901 had the same general form, the first having 55 square metres surface and being propelled by a motor of 9 horse power, while the second (Santos-Dumont No. 6.) had 28 square metres surface and a motor of 20 horse power. Assuming that the resistance of the air is proportional to the surface of the balloon and to the square of the velocity, it may be computed that the balloon of 1901 should have attained a velocity of 10.6 metres per second, instead of 8 to 8.5 metres. The principal cause of the discrepancy was the pitching of the balloon, which was especially marked in the second machine. The pitching, which interferes materially with the speed, has a variable amplitude, depending upon complex laws, and increasing with the speed. This is undoubtedly the principal obstacle against which dirigible balloons have to contend, since the speed should attain 13 metres per second in order to be able to contend with the wind eight times out of ten. There is therefore the difficult contention between two opposing problems in the design of a successful dirigible balloon, the attainment of a high speed and the securing of a high degree of stability when in motion. With these requirements must be included the need of a still lighter and more powerful motor, so that the problem of the construction of an entirely successful dirigible balloon must still be considered but partially solved.

We have reviewed elsewhere in this issue the experiments of Mr. Wilbur Wright along the same lines as those originated by the late Mr. Lilienthal, and it is not improbable that some of Mr. Wright's experiences may apply to the balloon of Santos-Dumont.

The Industrial Uses of Alcohol.

SEVERAL months ago, (November, 1901,) we noticed in these columns the paper of M. Lucien Perissé contributed to the transactions of the Société des Ingénieurs Civils de France upon the conditions existing for the economical use of methylated alcohol in internal motors. Since that time there has been held, in the court of the Grand Palais des Champs Elysées, in Paris, an exposition of apparatus and methods of utilising alcohol in the arts, and from papers by M. G. Coupan, and M. H. Guérin, in *Le Génie Civil* we abstract some of the prominent features of the exposition.

The necessity of providing some commercial outlet for the amount of alcohol produced in France will be understood when it is stated that the total production of alcohol in France for 1898 was 2,400,000 hectolitres (52,851,000 British gallons), and that this has been greatly exceeded with the remarkable production of wine during the past year, and with the production of alcohol from the waste products of the beet-sugar factories. It has been found impossible to export the excess product in competition with the production of other countries, and in consequence an outlet is sought by providing new applications, and it was to desseminate knowledge of these applications that the exposition was organized.

The exhibits were divided into three classes, the first consisting of stationary motors, portable engines, and carburetters; the second of automobiles and motors for navigation; while the third contained apparatus for heating and lighting.

For all industrial purposes the alcohol is *dénaturé*, or rendered unfit for drinking, by

the addition of a certain portion of methylated spirit, while for use in motors it is also frequently carburetted with benzine or some other hydrocarbon, in order to enrich its calorific value.

Fifteen motors were exhibited, and these were tested in a very thorough manner, in order to determine the value of alcohol as a source of motive power. The tests were made at full load, half load and no load, both with ordinary methylated alcohol and with alcohol carburetted to 50 per cent. The power generated was absorbed by brake, and the fuel in each case was subjected to chemical analysis. The results of the tests are fully tabulated in the paper of M. Coupan, and the general figures only can be given here. The methylated alcohol itself shows in the Mahler bomb a calorific power of 5,900 calories per kilogramme. The alcohol carburetted with benzine or coal-tar naphtha has a calorific power 1.43 times that of the pure alcohol, so that the consumption of the carburetted alcohol may be reduced to its equivalent of pure alcohol by multiplying by 0.7.

The consumption per h. p. hour ranged from 0.630 kilogramme and over for the small motors or 2 h. p. and under; 0.500 kilogramme for the motors between 2 and 10 h. p.; and 0.382 kilogramme for the one motor of 16 h. p.

The automobiles were tested upon a track, and the tabulated data and results give the consumption per ton-kilometre, the average being 0.128 kilogramme of alcohol, carburetted 50 per cent., speeds as high as 48 kilometres per hour being attained.

Quite as interesting as the applications of alcohol for power are its uses in connection with lighting, and it is this portion of the exposition which is discussed by M. Guérin.

The feeble illuminating power of the alcohol flame renders it necessary to utilise the heating effect to raise another substance to incandescence, and in nearly all the lamps exhibited the arrangement was that of an alcohol flame to heat an incandescent mantle of the Welsbach type. Many of these lamps were of high power, using a forced blast and an intensified draught. By vaporising the alcohol under pressure, and mixing it with air, illuminations as high as 634 candles were obtained from a single burner, the general arrangement being similar to the well-known petroleum incandescent lamps of high power.

A number of such lamps are described in detail of M. Guerin, including the Denayrouze, Kornfeld, Washington, Delamotte and others. In some of these the ordinary methylated alcohol was used, and in others the carburetted fluid, as in the motors. The only data of consumption available for record is that of the Hantz lamp, which gave a light of 8 carcels for 7 hours with a consumption of 1 litre of alcohol, and a light of 13 carcels with the same consumption for 5 hours. This corresponds to a consumption of 13 to 14 grammes of alcohol per carcel-hour.

The heating appliances resembled very much those in general use in the United States for use with gas, and with these were several forms of burners and appliances for industrial purposes which should prove very useful.

The whole result of this exposition should be to give alcohol a fair trial in the broad fields of heating, lighting, and motive power on a commercial scale, and while it is not to be expected that it will become a fuel of general adoption, there is little doubt that it is only the question of price which shall limit the consumption of the surplus output in this manner. Legislation and the regulation of taxation will doubtless have much to do with the cost, and if it can be made certain that the product can be so permanently unfitted for drinking as to make fraud impossible, the question of taxation may possibly be eliminated, and the laws of supply and demand be permitted to regulate the price.

The Deformation of Wires.

THE question of the resistance of materials is far from being as simple as it was formerly considered, and the attention of the engineer is being directed in many ways to apparent anomalies which should lead him to be very cautious in making assumptions which formerly would have been considered entirely legitimate.

An excellent example of this is found in the results of a study of the deformations of metallic wires under various stresses, made by M. E. Lenoble in the mechanical laboratory of the Faculty of Sciences of Lille, and

presented by him in a paper before the Société Industrielle du Nord de la France. From a publication of his paper in a recent issue of *La Revue Technique* we make some abstracts, showing the general trend of his observations.

If we assume a wire suspended with a weight attached to the lower end and are provided with means for determining its variations in length for various changes in load we may make the following experiments. Starting with a load sufficiently great to stretch the wire taut, we may add a succession of supplementary weights, recording the changes in length of the wire, and then, by successively removing the weights we may return to the original loading. The wire will then have passed through what M. Lenoble terms a cyclic variation of load, or a double oscillation. Under these conditions the wire frequently fails to return to its original length, but instead is permanently deformed. If it is now subjected to a second cycle, there will follow a second permanent deformation, and this may be followed by a third, etc.

By plotting the curves corresponding to a series of such cycles, M. Lenoble shows that the ascending curve of any cycle lies at first below the previous descending curve, but subsequently crosses it in ascending to a higher value, this operation being repeated for each cycle until rupture occurs. If the loading and unloading be continued many times, keeping within the elastic limit, the paths traced by the elongations and contractions of the wire, which at first form loops, gradually coincide, thus forming what M. Lenoble terms a closed cycle.

The various cycles depend largely upon the state of the metal, a much greater number of oscillations being required for a soft or fully annealed wire than for one which is hard drawn. This fact led to the idea of using the method for the study of the effect of molecular disturbance upon the resistance of the material. Many series of tests and observations upon wires with loads far below those below the breaking strength, as well as with those near the point of rupture, the behaviour indicating very clearly the internal changes which must take place before yielding occurs.

Researches of this kind show the importance of investigating the behaviour of materials under the conditions which occur in actual service, and if we are to be assured of stability in structures and machines it is most desirable that the methods of testing be modified so as to reproduce in general at least the conditions of actual service. Metals are not carefully placed with the load acting in the precise geometrical axis, carefully applied up to the point of rupture without shock, as is frequently the case in high-class testing machines. On the contrary, materials are subjected to loads of varying magnitude at irregular intervals, often abruptly and with shock, and rarely in the axis of figure. While such conditions are supposed to be covered by the provision of a factor of safety, this is but a makeshift for more precise information, and any attempts to discover more accurately the real action of materials under working conditions, must be welcomed and encouraged.

The Conservation of Energy.

THE fundamental law of natural science —the law of the conservation of energy— is also the fundamental law of the science of engineering. It is with these words that Professor Kammerer opens a most interesting discussion of the law of the conservation of energy considered from the standpoint of the engineer, in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure.*

Thus the function of the engineer is to convert and distribute the forces of nature in such a manner as to free mankind from the burden of bodily labor, and place him at liberty for higher fields of culture. The most important work of the engineer lies in the conversion of the energy which the sun has accumulated in fuels as chemical energy and in water as hydraulic energy, into available mechanical energy through the medium of prime movers. This being accomplished, the further work of the engineer is to apply this mechanical energy to the tools and machinery of applied industry for the supplying of the material needs of mankind.

Viewed in this light it is seen that the true aim of the engineer should be to accomplish his results with the least expenditure of human labor and with the minimum loss both of materials and of mechanical energy. Of course the acceptance of the law

of the conservation of energy precludes the idea that there can be such a thing as the loss of energy, and, from the standpoint of the engineer, energy can only be considered lost when it is misapplied, or deviated in direction from the line in which he is endeavoring to apply it. Useful energy, therefore, must be understood to mean simply that portion of the energy under consideration which has been successfully controlled and applied to the purpose in hand, as compared with that portion which has eluded capture and gone on its way unharnessed.

Some examples will render clear the manner in which an intelligent application of the law of the conservation of energy may conduce to the higher efficiency of a device, and an excellent instance is found in a hoisting plant, such as is used in mining. This is one of the simplest as well as one of the most important mechanical devices, and the history of its gradual improvement shows the advantage which the application of scientific principles may bring even to such a simple device as a windlass.

The earliest form of mine hoist consisted of a rope and bucket operated by a windlass, operated by animal or water power. The ore was filled into the bucket and hoisted to the surface by the energy applied to the windlass, and the empty bucket lowered again to the bottom. Here the useful energy was measured by the contents of the bucket and the velocity with which it was hoisted, while the energy from which no useful effect was obtained depended upon the weight of the empty bucket and that of the rope. Apart from the unused energy involved in the movement of the rope and the bucket, such a device is wasteful in other ways. Much time was lost in loading the bucket, and at the same time the slow speed of hoist possible with an unguided bucket in the shaft was far from economical. The entire time of descent of the empty bucket was also ineffective, so that the total efficiency of the device was unavoidedly low.

Consider now the manner in which improvements were introduced, and the extent to which they acted in accordance with the law of the conservation of energy.

By the introduction of a cage, controlled by guides, instead of a freely swinging bucket, the loading capacity may be materially increased, and greater rapidity of hoist allowed, but at the same time this introduces a greater proportion of dead load. The increased speed is a gain, but with it come increased resistances from friction and air resistance. The loss of time involved in the descent of the empty bucket or cage is next removed by the introduction of a second cage and double drum, one cage descending while the other in being hoisted, but with this gain comes additional dead weight. Thus we see a general increase in capacity, but also see it attained without material increase in efficiency. As an example of such a hoisting plant data are given from the salt mines at Heilbronn, where out of a total expenditure of 400 h. p., about 200 h. p. are effective, or an efficiency of 50 per cent. is attained. The shaft at Heilbronn is only 200 metres deep, but Professor Kammerer applies the same examination to the hoisting machinery of the Tamarack copper mine in Michigan, where, with a shaft 1,800 metres deep, but 1,600 h. p. are utilised out of 4,500 h. p.

The Tamarack machine is provided with conical winding drums, for the purpose of equalising the effect of the varying weight of rope, but Professor Kammerer points out that a better equalisation would be obtained by the use of suspended ropes or chains beneath the cages, and he constructs diagrams to show that with such equalisation the total energy required would be but 3,500 h. p., for a useful effect of 1,600 h. p.

It has been suggested that electric driving might be used for operating hoisting machinery, but there would be no advantage in so doing merely as a substitution for mechanical driving. If however, the machinery were so installed that the negative work of the descending cage and accompanying weights generated current for use in subsequent hoisting, a marked increase in total efficiency would necessarily result.

This is but a single example of the stages in which increasing efficiency in a machine may be traced to a gradually increasing conformity to the conditions imposed by the law of the conservation of energy. Many improvements are made, however, simply as the result of costly experience, slowly gained, when a thorough consideration of the physical laws involved would have led at once to high efficiencies.

The Cost of Power.

NEXT to the cost of labor the cost of power probably enters into the total cost of manufacture to a greater extent than any other element. In some instances, indeed, such as the manufacture of calcium carbide, the power cost is the principal factor. With the rapid introduction of labor saving machinery the proportion which power bears to labor must be a continually increasing ratio, more and more of the actual work being performed by machinery, the human element being reduced to that of guiding and directing the power by which the work is effected.

It is not always easy to compute the exact cost of power, or to estimate the cost for any proposed undertaking, and hence the papers of Mr. C. D. Gray, in the *Journal of the Franklin Institute*, giving a systematic arrangement of data relating to the cost of power from various sources, and various localities should prove of much service.

Mr. Gray takes up successively animal power, wind power, water power, steam power, and gas power, gathering data from many sources, both as to cost of installation and cost of operation and maintenance, and follows these with some discussion of methods of power transmission and distribution.

Animal power is dismissed with brief comment, the data being mainly from old and well-known sources. Any attempt to determine the efficiency of human or animal power on a thermal basis is misleading, and indeed the latest researches indicate that the development of muscular energy is a result of direct conversion of the food into electrical energy, without the intermediate stage of manifestation as heat. The high cost of human energy limits its use to purposes in which the effort of the mind as well as that of the body is required, and for such other purposes as can best be accomplished by its use regardless of cost.

Wind power receives a passing mention, its irregular character outweighing its cheapness, except for certain purposes. In general the examples given show that for the small powers used the cost is about one-half that of steam power.

Leaving these comparatively unimportant prime movers, Mr. Gray proceeds to examine data concerning the two great sources of mechanical energy; water power, and steam power.

Since the cost of water power depends to a large degree upon the cost of installation of the plant, the character of hydraulic plants may be of two kinds, one in which a large quantity of water is available but having a small head; the other, in which a small amount of water is at hand, but with a large head. With the former the turbine class of water wheel is more generally used, with the latter the tangential or impulse wheel is usually employed. Good modern wheels of either style will give an average efficiency of 80 to 85 per cent when operated under the head for which they are designed.

The cost of plant varies with the character, ranging, in the tables given, between $24 and $120 per brake horse power. The average cost per horse power, not including dam, is $53.41, or with dam, $79.55. The actual cost of water power is given as $10.72 per horse-power year. At Niagara the selling price is $13 per h. p. year, and at Lawrence from $19 to $22, while the lowest price in Canada is $6.25. A fair average may be taken from $10 to $15.

The disadvanges of water power, apart from possible inconveniences of location, are the necessity for storage capacity for water, the difficulties connected with close speed regulation, and the probability, in any locality, of the gradual diminution of supply, owing to climatic changes.

The cost of attendance of water-power plants is less than that of steam, or other plants, and, on account of the absence of a fuel bill, the operating expense is very small; but, on the other hand, the first cost

is large, and therefore the fixed charges are correspondingly greater than with other kinds of plants. The depreciation and repair bill is less than in the case of steam, an allowance of 4 per cent. usually being considered ample to cover these items, while the corresponding allowance for a steam or gas-engine plant is 10 to 15 per cent.

Coming now to steam power there are again various types of plants to be considered. While the steam engine may be considered to have nearly reached its limit of economy, there are some lines along which improvement may be expected. Thus the use of higher steam pressures, and the employment of superheated steam, are still to be further exploited, while the introduction of the steam turbine may develop possibilities for slightly increased economy. Taking existing pressures and engines, we have a large amount of data, which Mr. Gray has arranged and tabulated.

The average evaporation of modern steam boilers, from a list containing 37 water-tube, and 23 tubular boilers, is 10.86 pounds of water per pound of combustible. Taking the engine tests, they are grouped according to construction, and results given in pounds of steam required per horse power hour. Thus the average for simple automatic, non-condensing engines is 33.4 pounds per h. p. hour, while for simple Corliss non-condensing engines the steam consumption is 28.9 pounds. When engines of these types are operated condensing the consumption for the automatic engines is 22.2 pounds of steam, and for the Corliss engines, 20.2 pounds. The compound condensing Corliss engine, a type now generally adopted for power houses, gives, as an average of 57 tests, a steam consumption of 15.74 pounds per indicated horse power, while for triple expansion engines, the consumption is lowered to 13.3 pounds.

The cost of steam plant varies greatly with the locality, size, kind of machinery, etc. The average of 23 plants of various kinds ranges from $28 to $70, the average being $50, exclusive of cost of buildings. The operating cost is very variable, the factors including the kind and steadiness of load, the number of hours of service, the quality and cost of fuel, the efficiency of boilers and engines, and many others. The tabulated results range from 0.31 cents to 2.88 cents per horse power hour, the average being 0.95 cent, or very nearly one cent per horse power hour, of actual operation or from $30 to $70 per year according to the number of hours run.

The gas engine, originally supposed to be applicable for small powers only, is now pressing forward into the general field of prime movers. Engines of 100 horse power are not uncommon, and motors of 1000 horse power have been put into successful operation. The first and greatest advantage of the gas engine is its high thermal efficiency. With this comes the advantage of the possible use of inferior and low-priced fuel in gas producers. When it is practicable to use the waste gases from blast furnaces the fuel cost is that of a by-product, while natural gas is used to great advantage.

The calorific values of various gases are given by Mr. Gray, the tabulated values being grouped according to the method of generation, the averages of each table being given here. Thus natural gas averages 1,033 British thermal units per cubic foot, coal gas gives 706 B. T. U., water gas, when carburetted, 651 B. T. U., and when uncarburetted 319 B. T. U. Producer gas is much leaner, giving an average of but 143 B. T. U., while blast furnace gas yields only 102 B. T. U. per cubic foot. The quantity of gas used per horse power naturally varies with the value of the gas ranging from about 10 cubic feet per h. p. hour for natural gas to about 100 for the lean producer and blast furnace gases, but the relative cost of the gas must also be considered. Blast furnace gas is practically a waste product, while in a by-product recovery gas process, such as the Mond process, much of the cost of gas generation is saved.

In Mr. Gray's tables the cost of gas power ranges from about 1 cent per h. p. hour, using producer gas, to 3 cents per h. p. hour, using coal gas.

The cost of gas plants does not vary greatly from that of steam plants, the cost of producers or generators being about $11 per horse power, or about the same as that of steam boilers.

Taking the first cost of a gas engine plant as the same as that of a steam plant of the same capacity it will occupy less space, be much safer and require much less water. The producer requires less attention than

the boiler, and the gas may be stored, thus avoiding difficulties of irregularity. Under such circumstances a horse-power hour may readily be produced from 1 pound of coal or its equivalent, so that when the cost of fuel is given, the cost of power may be determined.

Mr. Gray has certainly done good work in collecting and arranging the mass of data to which we have been able to refer but briefly, and his work will doubtless form the basis for many future computations.

Progress in Aeronautics.

THE somewhat showy performances of the exploiters of dirigible balloons have rather cast into the shade the less pretentious efforts of those who have been working with aeroplanes, but still there are many who believe that the problem of aerial navigation will ultimately be solved by a machine without a gas bag.

The experiments of Lilienthal, interrupted by his untimely death, have not been forgotten, and in an interesting paper, presented by Mr. Wilbur Wright before the Western Society of Engineers, and published in the *Journal* of the Society, we have an account of a continuance of those experiments, extending them to a much larger scale.

Mr. Wright divides the difficulties which obstruct the pathway to success in flying machine construction into three general classes: Those which relate to the construction of the sustaining wings; those which relate to the generation and application of the power required to drive the machine through the air; and those relating to the balancing and steering of the machine after it is actually in flight. The first two of these are to a certain extent solved but the third has not been fully appreciated nor its importance understood.

Lilienthal seems to have been the first man who really comprehended that balancing was the first, instead of the last of the great problems in connection with human flight. Leaving the question of motive power out of consideration, he devoted himself to a study of gliding flight, by using aeroplanes, launched from a suitable eminence. His success is attested by more than two thousand successful trips, and he lost his life only by a breakage of his machine.

Taking up the work where Lilienthal left off, Mr. Wright and his brother have constructed a larger gliding machine than has been attempted by any one, and with a boldness fully equal to that of their unfortunate predecessor they have succeeded in gliding for distances of nearly 400 feet, having the apparatus during that time in excellent control.

The principal differences between the machine of Wright and that of Lilienthal are in the methods of guiding and balancing. The method of control of Lilienthal, which consisted in shifting the body to cause the centre of gravity to coincide with the centre of pressure, did not seem sufficiently quick or effective, so a system was contrived consisting of two large surfaces on the double-deck plan, similar to that of Mr. Octave Chanute, and a smaller surface placed a short distance in front of the main surfaces in such a position that the action of the wind upon it would counterbalance the effect of the travel of the centre pressure on the main surfaces. Thus changes in the direction and velocity of the wind have little disturbing effect, and the operator is required to attend only to the steering of the machine, which is effected by curving the forward surface up or down. The lateral equilibrium, and the steering to the right or left is attained by a peculiar torsion of the main surfaces, which is equivalent to presenting one end of the wings at a greater angle than the other. The operator, instead of maintaining an upright position, lies horizontally, this offering less resistance to the wind.

The first machine constructed on these principles had 165 square feet of area, but experiments with it, while indicating that the work was on the right track, Lilienthal's tables of areas and supporting angles were found to be incorrect, and the lift was less than was needed, and after further experiments a second machine was built with an area of 308 square feet.

After some practice, especially in the modification of the curves of the aeroplanes this larger machine was got to work most satisfactorily, as photographs showing gliding flight prove.

Although such experiments serve to give information concerning only the third of the three obstacles to be overcome in successful

flight, the balancing and guiding, yet this is in itself no mean achievement. The construction of a much larger machine, and its equipment with a light and powerful motor, so as to avoid the necessity of limiting flights to down-hill gliding, aided by the wind, and to permit predetermined progress and direction, may now be far more intelligently undertaken, and with such a combination a veritable flying machine would be produced, one differing as much from a dirigible balloon as an ocean liner from a Chinese junk.

Progress is evidently being made on all sides in the development of the essentials of mechanical flight, and not the least progress which has been made is the overcoming of popular prejudice against experimental work in this line. Not so very many years ago any engineer of reputation who ventured to countenance the construction of a flying machine would have found that reputation gone. To-day he meets with intelligent co-operation and encouragement, a fact which in itself shows the advance not only in the work of the engineer, but in the intelligence of the public.

The Pollution of Streams by Manufactories.

AMONG the various causes of the pollution of water supply that due to the discharge of manufacturing wastes into streams is an extensive and increasing one. For this reason the paper of Mr. H. W. Clark, chemist to the Massachusetts State Board of Health, in a recent issue of the *Journal of the New England Water Works Association* is both opportune and valuable.

Although the subject has received attention at various times, it is only within the past few years that it has been given systematic study and investigation, the disposal of domestic sewage having occupied the attention of most communities. Since 1895, however, a succession of practical investigations have been carried on by the Massachusetts board and much valuable practical information obtained. Many of the small streams of Massachusetts are at places, or along their entire course, foully polluted by waste liquors from various manufacturing plants. Some of the large rivers, such as the Merrimac, moreover, are receiving immense quantities of manufactural wastes, together with domestic sewage, and their waters are prevented only by reason of their volume from becoming as foul in appearance and character as the waters in some of the smaller streams. All this has been a natural consequence of the growth of manufacturing industries, but in the light of present knowledge, it is evident that there will arise a demand for such a cleaning up of rivers now polluted from factory wastes as can reasonably be required from the corporations responsible.

An examination of the subject shows that the principal manufactural pollutions are from woolen mills, paper mills, and tanneries. Other industries cause much pollution in places, but they are not so widespread.

Mr. Clark examines in detail the nature of the wastes of these three principal kinds. The wastes from woolen mills are principally those caused by the scouring and rinsing of wool in preparation for its manufacture, together with the waste liquor, in some instances, from washing the cloth after manufacture. They form a serious pollution, both on account of the large amount of organic matter present, and because of the extreme difficulty with which this matter is decomposed or changed by bacterial action. Thus investigations show that one mill discharged about 67,000 gallons of liquor per day, carrying 12,000 pounds per day of solid matter. In a second mill, where the scouring was more concentrated, being carried on with a less volume of water, the solid matter discharged amounted to 7,500 pounds for each 12,000 gallons of wool liquor. Experience shows that such a liquor cannot be caused to nitrify when passing through intermittent sand filters unless a certain volume of domestic sewage is added to it, but that when the volume of domestic sewage is very large in comparison with the volume of waste liquor, nitrification will occur, and good results be obtained. As the result of a number of experiments it appears to be conclusively established that the filtration area seems to gather power to purify the mixed town sewage and woolen-mill waste more efficiently after it has been applied to it for some time; that is, the bacteria present seem to become, after a time, more and more equal to the task of breaking up even the stable organic matters in the wool liquor.

and causing them to undergo bacterial oxidation.

Tannery wastes form a very strong offensive liquor, highly charged with decaying animal tissues, the bran that is added to cause fermentation to take place in certain tanks, and various chemicals used in preparing, tanning, and preserving the hides. It is also at times highly colored by the different dyes used in coloring the hides, and the spent tan liquor. In spite of this general mixture the wastes show good results on sand filters. Thus one sand filter, containing four feet in depth of sand, to which this tannery sewage was applied at rates of 30,000 to 120,000 gallons per acre daily, gave a fairly clear, almost odorless liquid without much color, and well nitrified.

When germicides, such as arsenic, have been applied to protect the hides in transit, or when sulphide of arsenic is used in removing the hair, the presence of the arsenic checks or destroys the organic growths. Experiment has shown, however, that although this sewage will not nitrify in filters if applied directly, yet if it is first passed through a coke-breeze strainer or over iron filings, the arsenic present will unite with the iron, and the resulting liquor be of such a character that it may easily be purified upon intermittent sand filters. Such a sewage, although often nearly sterile before the preliminary straining through coke or iron, shows abundant bacterial growth when it appears as an affluent from this strainer before passing to the sand filter.

The waste liquors from paper mills vary very much but generally contain a large amount of slowly decomposable organic matter, such as cellulose and a small amount of easily decomposable nitrogenous organic matter. The principal difficulty which they offer is their volume, and they are easily purified when mixed with fair volumes of domestic sewage. A simple method of treating such wastes in large quantity, however, is to pass them directly through a coke or cinder strainer, it being found that even at rates as great as one million gallons or more per acre daily, the resultant effluent is of fairly good quality, and the polluting matters in the liquors, being largely in suspension, are caught at the surface of the strainer and may be removed and burned.

Besides the examination of the three main kinds of factory wastes the Board has investigated a large number of discharges of other kinds, usually with favorable results, special treatment being required in special cases. The main point, however, appears to be clearly established, namely, that the purification of factory wastes may be successfully carried on in connection with that of domestic sewage, without imposing hardships upon the factory owners, and with great benefit to the communities through whose areas the polluted streams pass. Absolute purity may not be practically attainable, but an excellent degree of purity is entirely practicable, to the great advancement of the cleanliness of the streams, and the health of all concerned.

Resistances in Canal Navigation.

In the recent report to the Governor of the State of New York upon the subject of the barge canal, Mr. Elnathan Sweet made reference to the bearing of the experiments of Herr Haack in Germany upon the resistance to be overcome in the navigation of the proposed 1,000-ton barge canal. These results were so different from those generally understood to exist that they became the subject of some comment and discussion, and in consequence Mr. Sweet has contributed to the *Proceedings* of the American Society of Civil Engineer a paper discussing some important phases of canal navigation as illustrated by recent experiments in Germany. The experiments referred to are those of Herr Haack, which Mr. Sweet describes and discusses analytically. The well-known reputation of the distinguished German engineer lends especial value to the experiments, and the discussion by Mr. Sweet places them before the profession in English-speaking countries in a very acceptable form.

The experiments were made on the Dortmund-Ems canal, near Lingen, the canal at this point being of the usual trapezoidal section, with a mean area of 600 square feet, and a mean centre depth of about 8½ feet. They were made by towing steel barges by means of a steam tow-boat, and the object was not only the determination, by accurate measurements, of the actual resistance at varying velocities and ratios of prism to boat section, but also the determination, by accurate instrumental work, of

the precise condition of the prism of water in a canal while a vessel was being forced through it; on the theory that the relative conditions of this prism of water at rest and while a boat was moving in it, should form a measure for determining the entire resistance of the boat navigating it.

The theory, advanced by Haack, is as follows: When a vessel moves in a canal, unlike a vessel moving in open water where the water moves freely from all directions to fill the void behind it, the water can only reach this void by moving back through the narrow spaces between the boat and the bottom and sides of the canal. Immediately in front of the wave made by the boat's prow the water is absolutely at rest, while behind the prow wave, the whole length of the boat, and for some distance behind it, the water sinks below its position before being disturbed, with a back flow seeking to restore the normal position behind the boat. The extent of this sinking of the water surface and of the velocity of this negative current depend on the rate of the boat's motion, its model, the friction of its immersed surface, the friction of the canal bed, and of the water particles on one another.

The experiments of Haack were made with the steam tow boat Goedhardt, 68 feet long, 16.4 feet beam, and 5 feet draught, together with the steel barges Emden and Dortmund, these being exactly alike of 215 feet length, 26.9 feet beam, and 6.6 feet draught, except that the Dortmund was supplied with a boiler and engine for self propulsion. There was a third barge, the Lloydkahn, 180 feet long, 26.3 feet beam, and 6.6 feet draught, these giving a sufficient variety of ratios of immersed section to canal cross section to provide data and results of much value.

The analytical examination of the conditions is given in full in Mr. Sweet's paper, and the conclusions only can be given here. Instead of tabulating the results, they are presented in the form of curves, and a few figures from the several curves will serve to show the influence which the ratio of barge section to canal section has upon the total resistance. Thus with the Goedhardt, under her own steam, with the ratio of boat section to canal section of 8.50, the mean negative velocity for a speed of four miles an hour, was 0.5 foot per second, while for the Lloydkahn, with a ratio of boat section to canal section of 4.30, the negative velocity for the same speed was 2 feet per second, and for the Emden, with a ratio of 4.15, the negative velocity was 2.6 feet per second.

As Mr. Sweet says, there is no phenomenon, incident to canal navigation, where considerable speed is desired, so important in determining the proper section of canal prism as this of the negative current induced by its operation, as such current cannot be permitted to acquire a velocity destructive to the integrity of the earthwork, and he calls attention to the fact that these experiments of Haack are the first and only contribution to our knowledge of the subject.

Especially is it important that there should be sufficient depth of water under the boat. It is well known that when a boat moves in shallow water, the proximity of the boat's bottom to the ground retards the speed, owing to the friction among the particles of water lying between the boat and the ground induced by the boat's surface carrying along the water adhering to it, while the friction of the ground retards the water adjacent to its surface, thus setting up motion and friction among the particles of water between these surfaces.

While these results are all most valuable, especially from the fact that they were obtained from full sized boats in a navigable canal, it should be possible to extend them greatly by experiments made in a marine testing tank, such as that in the Navy Yard at Washington. The cost of providing a number of models of varying midship section would be small, and the admirable recording mechanism connected with the towing apparatus would permit the determination of all the quantities with a high degree of precision.

Modern Practice in Rolling Rails.

THE behaviour of steel in response to various kinds of treatment has been a subject of study for many years, but it is only recently that the results of such study have been put into practical application in actual manufacture. Formerly everything connected with the manufacture of steel was empirical and arbitrary, being based entirely upon the results of experience. This

state of affairs was followed by the introduction of testing machinery, and the physical properties appeared in specifications and efforts were made to conform to them in manufacture. Later came the realization of the importance of a correct knowledge of the chemical composition of steel, as influencing its strength and general behaviour, and the chemical laboratory was added, to enable the results in the testing machine to be accounted for, and in some measure to enable certain desirable results to be reproduced commercially. Still it was realized that there were other conditions which affected the character of the product, and as the influence of heat treatment and the nature of the effects of the mechanical operations of manufacture were studied it was found most desirable that they should be known and controlled.

The comparatively new science of metallography, or the study of the molecular structure of the metal by the examination of polished and etched sections under the microscope, furnished the means for the intelligent introduction of improved methods of working. The result has been a decided modification in the practice of working steel, and the effect which such modification has had upon the rolling of rails during the past year is discussed in a paper by Mr. S. S. Martin, in a recent issue of the *Iron Age*.

The requirement of the railway engineer is for rails which will wear well, and it matters little to him if the chemical composition conforms to certain specifications, or the demands of certain tests have been complied with, if after all the rail wears badly. Now it has been known for a number of years that rails with a non-granular structure have the best wearing qualities. This non-granular structure, moreover, is found especially in light rails, and it is not uncommon to hear comparisons made of the better wearing qualities of rails used a number of years back, compared with the heavier modern rails.

In order to explain the effect of temperature upon rolling, Mr. Martin examines the behaviour of steel in cooling, and shows that there are certain points of retardation in cooling, of sometimes even of perceptible increase of temperature, these being the well-known points of recalescence. Soft steel has three such points, but rail steel of 0.50 per cent. carbon has but one, this lying about at 700° to 725° C. The structure of the rail depends for the size of its granules upon the rate of cooling to this critical point, and the higher the temperature above the critical point, the larger will be the grains, while below the critical point no change of structure takes place. The best structure will therefore be obtained by rolling the rail as nearly as possible at the critical temperature. If the piece of steel in rolling is delayed at any point before finishing it will help the structure directly in proportion to the amount of reduction in the remaining passes, because, while the bar is being held, the structure is crystallizing, and the higher the temperature the larger the granules to the critical point.

To obtain a non-granular structure throughout the rail must be reduced earlier in the rolling, and the bar or bloom should not be reheated, but should be rolled direct from the ingot. The amount of reduction greatly influences the granular structure, since a single pass is incapable of breaking up the granular structure for more than a certain depth.

It is here that the importance of the study of the microscopic structure of the metal is of importance. Professor Albert Sauveur has prepared a set of micro-photographs showing the appearance of steel forged at 650, 850, and 1,100 degrees C., the temperatures having been measured by use of the Le Chatelier pyrometer. These photographs form excellent standards for comparison with actual work, and a brief microscopic examination of a specimen of a rail enables it to be compared at once with the photographic standard, the result indicating very closely the actual temperature at which the rail was rolled. This gives a ready means of determining rolling temperatures, and admits of no dispute or question, besides possessing the great advantage of being applicable at any time after rolling.

We thus have another most important example of the application of laboratory science to the commercial side of engineering, and an illustration of the impossibility of predicting the limit to the uses of scientific research. The use of the microscope for the study of the structure of steel was at first looked upon as something of interest to the professor, but altogether too refined and

delicate for use in connection with actual work. To-day it may determine the acceptance of tons of material and the payment of thousands of dollars, and more important yet, it may prevent the breaking of a rail and the wreck of a crowded express train.

The Sewerage of New Orleans.

THE question of the drainage of the city of New Orleans has been under consideration for a long time, but apart from political questions the nature of the problem has made it a difficult one of solution. As a consequence there has been the spectacle of a city of nearly 300,000 inhabitants, situated in a hot and unhealthful climate, practically entirely devoid of any systematic provision for the removal of sewage.

In a paper by Mr. W. T. Crotts before the Louisiana Engineering Society, and published in the *Journal of the Association of Engineering Societies,* we now have a very complete account of the system of drainage planned for the city under the auspices of its own department of public works, after all attempts at a successful solution by private enterprise had failed. This system, while presenting no startling novelties, is a thoroughly sound treatment of a difficult problem according to well-known engineering methods, the magnitude of the work rightly being considered good reason for avoiding untried methods, however correct and adaptable in theory.

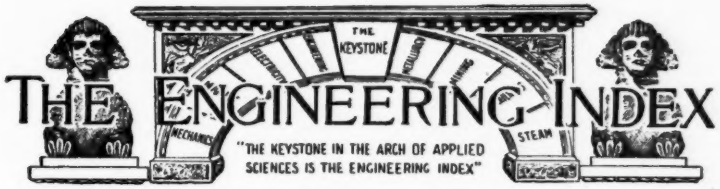
The natural difficulties are those due to the peculiar contour of the city, extending for a great distance parallel with the Mississippi river, and of comparatively shallow depth, together with the fact that the low-lying situation afforded a very bad soil and an entire absence of available natural grades. The entire system has had to be designed with artificial grades provided by depth of excavation in the bad soil, and arrangements made for the pumping of the sewage and its delivery into the river.

Before proceeding with the plans a careful investigation was made as to the distribution of population and the probable flow in cubic feet per second per acre, together with the probable direction and density of future growth in order to ascertain the future population for which sewerage facilities must be provided. With this was included an estimate for the ground water, an important element in this location, this alone forming 1,250,000 gallons per square mile in twenty-four hours. This quantity was estimated at one-third the annual rainfall, this estimate being checked by measurements made upon some of the old sewers.

The general system is naturally based on the topography of the city, and as the latter is situated on a bend in the river, with streets radiating from a hub situated far back, approximately at the centre of curvature of the bend of the river front, so the sewers are arranged to run back from the river front to a main collector situated about midway between the hub and the water front. The unit of the system is a pipe of 8 inches in diameter, and increasing in size as the flow increases the largest main finally attains a diameter of 6 feet for some distance before it reaches the pumping station. The larger sewers are of brick, resting on wooden foundations, while those below 24 inches are of vitrified pipe.

Naturally the greatest difficulty to be encountered is the soil. The grades must be obtained by underground slopes, while at the same time the work must be kept as near the surface as possible. The saturated and plastic character of the ground threatened damage to streets, curbs, and buildings wherever the deeper excavations became necessary, and yet a too shallow depth meant a too rapidly increasing number of dead ends and consequent first cost and annual expense of innumerable flush tanks. Taking all these points into consideration it was decided to adopt a minimum depth of 5 feet and a maximum depth of 9 feet for laterals, and 16 feet for sub-mains. These depths were not applied to the main sewers, for reasons of economy and efficiency.

Mr. Crott's paper contains very full details of the manner in which the whole of this difficult work has been planned out, and shows the completeness of a system the like of which can only be found, so far as local conditions are concerned, in the low-lying cities of Holland. The one redeeming feature in the situation is the presence of the Mississippi for a discharge of the pumped sewage. A series of careful experiments with floats showed the best point for discharge, where the current would carry the flow far away from the city, so that no trouble need ever arise from that cause.



The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

CONTENTS.

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CIVIL ENGINEERING

BRIDGES.

Arches.

The Theory of Arches (Beitrag zur Theorie der Gewolbe). Th. Landsberg. A mathematical discussion of the determination of the line of pressure in masonry arches. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 14, 1901. No. 45163 D.

Bridge Testing.

Conférence sur l'Experimentation des Ponts (Report on the Testing of Bridges). M. Rabut. An important paper presented before the Engineering Congress at Paris,

We supply copies of these articles. See page 811.

describing the construction and use if instruments for recording the deflection and vibrations of bridges in actual service. 10,000 w. Rev Gen des Chem de Fer—Nov., 1901. No. 45144 H.

Concrete Arch.

A Y-Shaped Concrete Arch Bridge at Zanesville, Ohio. Illustrated detailed description of a structure recently built to take the place of a wooden highway bridge, built to cross two streams which form a confluence in the midst of the city. 2000 w. Ry & Engng Rev—Dec. 21, 1901. No. 45007.

Fire and Load Test of a Concrete Arch. Charles L. Norton. An illustrated report of tests made with very satisfactory results. 2000 w. Ins. Engng—Dec., 1901. No. 44879 C.

Highway Bridge.

The Summer Street Bridge, Boston. Illustrated description of a 4-span highway bridge 100 ft. wide having heavy Pratt trusses and three steel piers of unusual construction. All special details are illustrated. 1500 w. Eng Rec—Dec. 21, 1901. No. 44998.

India.

Bridge Over the Indus River at Kotri, North-Western Railway. Illustration with brief description. 800 w. Ind & East Engr—Nov., 1901. No. 45035 B.

Monongahela.

Rankin Bridge for the Transit of Molten Iron. Illustrated description of a bridge across the Monongahela River for transporting molten metal to the Homestead Works. 500 w. Sci Am—Dec 7, 1901. No. 44768.

New Mexico.

Rock Island Bridge Over the Canadian River in New Mexico. Illustrates and describes the erection of a bridge 769 ft. in length, spanning the river at a height of 135-ft., in which some unusual methods were employed. 1200. Ry Age—Dec. 6, 1901. No. 44825.

Ottawa.

Construction of the Substructure of the Royal Alexandra (Interprovincial) Bridge at Ottawa, Canada. Guy C. Dunn. An interesting description of this work with plates. 5000 w. Can Soc of Civ Engrs—Adv. Proof—Dec. 19, 1901. No. 45005 D.

The Interprovincial Bridge, Ottawa. Illustrated description of a cantilever structure 2,287 ft. long with a channel span of 555 ft., carrying a railway, two electric car tracks, two sidewalks, and two roadways. The first part describes the structural features. 4300 w. Eng Rec—Dec 7, 1901. Serial. 1st part. No. 44817.

Railway Bridge.

The South St. Paul Belt Railway Bridge. Illustrated description of a steel bridge and viaduct 1,632 ft. in total length, with one 442-ft. draw-span. A single-track railroad is carried on top and a highway floor is carried below it 2,700 ft. Eng Rec.—Nov. 30, 1901. No. 44662.

Rolling Lift.

A Scherzer Rolling Lift Bridge in Brooklyn. Illustrates and describes a bridge to be built on Vernon Ave. over Newtown Creek, which has novel features. 600 w. R R Gaz—Nov. 29, 1901. No. 44668.

CANALS, RIVERS AND HARBORS.

Dredges.

Dredging Machinery (Baggerwerktuigen). C. H. Holst. A review of modern dredging machinery, both bucket and suction; also barges and auxiliary machinery in dredging work. 4000 w. De Ingenieur—Nov. 30, 1901. No. 45207 D.

New Satre Dredges for Service on the Lower Seine. Illustrated description of seaworthy suction dredges built for the improvement of this river. 1100 w. Engng—Nov. 22, 1901. No. 44737 A.

Dry Dock.

New Dry Dock at Baltimore. An illustrated description. 2500 w. Marine Rev—Dec. 19, 1901. No. 45022.

Isthmian Canal.

International Aspects of the Isthmian Canal. Gen. Henry L. Abbott. A critical comparison between the Nicaragua and Panama routes, forming an impressive warning against the folly of accepting the former. 3500 w. Engineering Magazine—Jan., 1902. No. 45054 B.

Nicaragua or Panama. Philippe Bunau-Varilla. Address to the Chamber of Commerce of the City of New York, with editorial. A comparison based on reports of Commissions. 5500 w. Sci Am & Sci Am Sup—Dec. 21, 1901. Serial. 1st part. No. 44972 C.

The Report of the Isthmian Canal Commission. Editorial discussion of a few features of the report which are of special interest. 2000 w. Eng News—Dec. 26, 1901. No. 45057.

The Report of the Isthmian Canal Commission. Reviews the leading results of the investigation of this Commission, which has cost $1,000,000, and lasted several years. 1700 w. Eng Rec—Dec. 14, 1901. Serial. 1st part. No. 44934.

Mississippi.

The Lower Mississippi River: Physical Characteristics, Methods of Improvement, Character and Volume of Traffic. J. A. Ockerson. An illustrated descriptive article. 7500 w. Jour Assn of Engng Soc's—Nov., 1901. No. 45073 C.

We supply copies of these articles. See page 811.

Obstructions.

Obstructions in Navigable Channels. Discusses the question of bascule or vertically moving bridges as against the old-time center-pier obstructions in connection with the plans for bridges over the Potomac. 1200 w. Marine Rev—Dec. 12, 1901. No. 44895.

Savannah.

Savannah Harbor. A. S. Cooper. Describes the natural harbor and the improvements made. Ill. 3200 w. Wis Engr—Dec., 1901. No. 44996 C.

CONSTRUCTION.

Concrete.

Important Concrete Construction in Zero Weather. Describes the methods used in putting in heavy foundations for a grain elevator in Buffalo in mid-winter. 700 w. Eng Rec—Dec. 7, 1901. No. 44824.

Dams.

A Remarkable Core Wall for an Earth Dam. Describes the building of a concrete and puddle core wall to a depth of 105 ft. below the surface of the ground for a dam rising but 23 ft. above the surface. 1900 w. Eng Rec—Dec. 21, 1901. No. 44999.

Criticism of the Masonry Portion of the New Croton Dam. Letters from John D. Van Buren and Elnathan Sweet, with illustrations. 1800 w. Eng News—Dec. 26, 1901. No. 45058.

Report Recommending Changes in the New Croton Dam and Jerome Park Reservoir. Report submitted to the Croton Aqueduct Commissioners, with a statement relating to the matters covered by the report, signed by Mr. Sweet. Ill. 8800 w. Eng News—Nov. 28, 1901. No. 44659.

The Limiting Heights of Earth Dams. An editorial discussion on the effect of the percolation of water through dams. 1300 w. Eng Rec—Dec. 7, 1901. No. 44815.

Foundations.

A New System of Foundations (Nouveau Système de Fondations). A. Casse. Describing a method of sinking metallic caissons by the aid of water jets; especially adapted for wet and sandy ground. 2000 w. Mem Soc Ing Civ de France—Sept., 1901. No. 45119 G.

Notes on Foundations. Gerald E. Flanagan. Discusses the application of engineering principles to foundation construction. 1000 w. Am Mach—Nov. 28, 1901. No. 44615.

Sinking Foundation Wells for the Koyakhai Bridge, Bengal-Nagpur Railway. Graves William Eves. Illustrated detailed description of methods used in difficult work in India. 2500 w. Eng News—Dec. 26, 1901. No. 45059.

Greenhouse.

The Largest Greenhouse in the World. Arthur C. Johnston. Illustrates and describes the construction of a greenhouse for rose culture at Edgely, Pa. 800 w. Eng News—Dec. 12, 1901. No. 44892.

Oiled Roads.

Oil for Clay Roads. Describes the treatment given a buck shot road near Clarkesdale, Miss. 1000 w. Eng Rec—Nov. 30, 1901. No. 44664.

Reinforced Concrete.

Concrete and Steel Prison Cell Construction, Boston Navy Yard. Illustrates and describes the cell construction in the prison at the Charlestown Navy Yard. 600 w. Eng News—Nov. 28, 1901. No. 44657.

Practical Applications of Reinforced Concrete. Jacques Boyer. A review of the principal systems, showing characteristic structures and methods of reinforcing concrete by imbedded metallic members. 4000 w. Engineering Magazine—Jan., 1902. No. 45047 B.

Reinforced Concrete Floors Constructed with Expanded Metal (Les Planchers in Béton Armé de Métal Déployé). With details of construction, strength, and cost, based upon work at the Elswick Works, Newcastle-on-Tyne. 1000 w. Revue Technique—Nov. 25, 1901. No. 45113 D.

The Applications of Reinforced Concrete (Des Applications du Ciment Arme). G. Liébeaux. Giving data concerning methods of construction and erection, with especial reference to works in and near Nantes, including the bridge over the Vienne at Châtellerault. 10,000 w. Rev Gen des Chem de Fer—Dec., 1901. No. 45145 H.

The Nassau County Steel-Concrete Court-House. Illustrated description of a 176 x 37-ft. building with 60 x 52 ft. extension, built with concrete-steel walls, columns, floors, roof, central dome, and ceilings. The details of design are explained and the method of construction briefly outlined. 2400 w. Eng Rec—Dec. 7, 1901. No. 44818.

See also Mechanical Engineering, Steam Engineering.

Steel Frame.

A Steel-Frame Church. Illustrated description of a 150 x 98-ft. stone and brick building with steel framework and roof. The vaulted ceiling of the nave rises 60-ft. above the floor, and there is a tower rising to a height of 125 ft. 1600 w. Eng Rec—Dec. 14, 1901. No. 44940.

Tunnels.

Simplon Tunnel (Simplon Tunnel). An abstract of the progress upon the Simplon tunnel works for the July-September quarter, 1901. 1800 w. Schweizerische Bauzeitung—Nov. 16, 1901. No. 45175 B.

We supply copies of these articles. See page 811.

The Flow of Water in the South Heading of the Simplon Tunnel (Wasserandrang auf der Südseite des Simplon-Tunnels). A detailed report of the sudden irruption of water into the Italian side of the Simplon tunnel works in September, 1901. 1000 w. Schweizerische Bauzeitung—Dec. 7, 1901. No. 45179 B.

The Flow of Water in the Simplon Tunnel (Irruption d'Eau dans le Tunnel du Simplon). An account of the sudden heavy discharge of water into the works of the Simplon tunnel in September, 1901. 800 w. Revue Technique—Nov. 10, 1901. No. 45112 D.

Tunneling.

The Pennsylvania Railroad Terminal in New York. Describes briefly the $60,000,000 plan for tunneling the North and East Rivers at New York and building a very large terminal station on Manhattan Island. 900 w. Eng Rec—Dec. 14, 1901. No. 44935.

Warehouse.

A Steel Warehouse for a Wholesale Grocery Company. Illustrated description of a 94 x 60-ft. steel-cage fireproof warehouse, 9 stories high, containing unusual features in the flooring and the arrangement of columns, made necessary by the nature of the business carried on. 1500 w. Eng Rec—Dec. 7, 1901. No. 44822.

The Design and Construction of the Modern Warehouse. Augustus N. Rantoul. Discusses the importance of the planning and of the economical and thorough construction if the property is to yield the best results. Ill. 2700 w. Br Build—Dec., 1901. No. 45067 D.

MATERIALS.

Cements.

Continental Opinion and Practice in Regard to Cement Testing. Resumè of the papers read at the recent Budapest meeting of the International Assn. for Testing Materials. 4200 w. Builder—Nov. 30, 1901. No. 44848 A.

The Inspection and Testing of Cements. Richard L. Humphrey. Reviews early tests made of this material, giving an illustrated account of the methods of testing developed; and discusses inspecting and sampling, chemical analysis, fineness, specific gravity, time of setting, etc. 6000 w. Jour Fr Inst—Dec., 1901. Serial. 1st part. No. 44844 D.

The Present State of Cement Testing in Germany. A report by Max Gary to the Budapest congress of the International Assn. for Testing Materials. Describes the standard Prussian tests and recommends alterations in the method of conducting them. 5400 w. Eng Rec—Dec. 14, 1901. Serial. 1st part. No. 44939.

Concrete.

Estimating the Cost of Concrete. Halbert Powers Gillette. Discusses the old theory and why it fails, and presents a new theory. 3500 w. Eng News—Dec. 5, 1901. No. 44795.

Fireproof Partitions.

Tests of Fireproof Partitions of the New York Building Department. A record of results obtained in a series of tests, with illustrations and editorial comment. The types tested were metal lath and plaster, terra cotta block, plaster composition block, and concrete block. 7700 w. Eng News—Dec. 26, 1901. No. 45055.

Resistance.

The Resistance of Materials (Von der Festigkeitslehre). A review of the development of the study of the strength of materials with especial reference to the theory of Mohr. 3000 w. Zeitschr Oesterr Ing u Arch Ver—Nov. 15, 1901. No. 45167 B.

Stone.

The Stone Industry in 1900. A review based on information given in a recently issued pamphlet of the U. S. Geol. Survey. 4800 w. Stone—Oct., 1901. No. 44809 C.

Variable Load.

A Diagram for Determining the Working Stress in Metals, with Variable Load. John H. Barr. Presents a graphical representation of the Johnson formula explaining its use and discussing the subject. 1700 w. Sib Jour of Engng—Dec., 1901. No. 44993 C.

Wood.

The Identification of Wood. Herbert Stone. An illustrated article outlining a plan for the identification and classification of timber. Discussion. 7700 w. Jour Soc of Arts—Dec. 6, 1901. No. 44909 A.

MEASUREMENT.

Metric System.

The Metric Convention and the International Bureau of Weights and Measures (La Convention du Métre et la Bureau Internationale des Poids et Mesures). C. E. Guillaume. M. Guillaume's second paper treats of the thermometric work, and also describes the various comparators used in the Bureau. 10000 w. Bull Soc d'Encour—Oct., 1901. No. 45129 G.

The Metric Convention and the International Bureau of Weights and Measures (La Convention du Métre et le Bureau Internationale des Poids et Mesures). C. E. Guillaume. M. Guillaume's third paper deals with the preparation and comparison of standards of length, also of the determination of the kilogramme. 12000 w. Bull Soc d'Encour—Nov., 1901. No. 45131 G.

We supply copies of these articles. See page 811.

Surveying.

The Closing of a Polygonal Survey by the Use of Modern Stadia Instruments (Festlegung eines Polygonalen Zuges bei Verwendung Neuer Instrumenten tur Optische Distanzmessung). E. Dolezal. A very full discussion and application of Prof. Schell's new tachymetric method. Three articles. 8000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov, 22, Dec. 6, 13, 1901. No. 45168 each B.

MUNICIPAL.

Septic Tanks.

Drinking Water from Sewage. Describes a plant at Milton, Mass., showing how a septic tank converts household waste into a wholesome water supply. 2500 w. Dom Engng—Dec. 15, 1901. No. 45004 C.

The Antecedents of the Septic Tank. Discussion of paper by Leonard Metcalf. 5200 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44686 E.

Sewage.

Sewage and Seaweed. Information concerning experiments made by Dr. E. A. Letts, of Belfast, showing that the occurrence of sea-lettuce in large quantities in any locality is associated with the pollution of the sea water by sewage. Also discusses schemes of sewage purification and means of mitigating the nuisance. 1200 w. Builder—Nov. 23, 1901. No. 44709 A.

Sewage Disposal.

Sewage Disposal at Wauwatosa, Wis. Illustrated description of septic tank and filtration works containing a new system of automatic control of the flow to the several filter beds. 1300 w. Eng Rec—Dec. 14, 1901. No. 44937.

The Continuous Filtration of Sewage. Editorial reviewing the continuous sewage filter of F. Wallis Stoddart. 1600 w. Engng—Dec. 13, 1901. No. 45042 A.

Sewers.

Estimation of the Cost of Sewer Construction. Emmett Steece. Read before the Am. Soc. of Munic. Imp. Gives an estimate of the cost of various kinds of work required in the construction, with diagrams. 2400 w. Munic Engng—Dec., 1901. No. 44758 C.

The Melbourne and Metropolitan Sewerage System. Illustrated description of the leading features of a separate system for an area of 200 sq. miles and an ultimate population of 1,000,000. The manholes, flushing apparatus, sewer construction, tunnelling and sewage disposal by irrigation are the principal subjects taken up. 3000 w. Eng Rec—Dec. 21, 1901. No. 44997.

The New Drainage and Sewerage System of New Orleans. Frederick Moore. An illustrated description of an installation presenting many difficult problems. 1300 w. Sci Am—Dec. 7, 1901. No. 44769.

The Sewerage of New Orleans. W. T. Crotts. Describes the conditions existing, the various schemes presented at different times, the final plan and its design. Ill. 5700 w. Jour Assn of Engng Soc's—Nov., 1901. No. 45075 C.

Street Lighting.

Prices of Electric Street Lighting in Massachusetts. Alton D. Adams. Considers the prices paid for the service of electric street lamps by all the important cities and towns of Massachusetts, with the object of determining whether variation exists, its extent, some of the modifying factors, and the exceptions. 3000 w. Munic Engng—Dec., 1901. No. 44757 C.

WATER SUPPLY.

Analysis.

The Bacteriological Analysis of Water and Its Interpretation. Charles Edward Amory Winslow. Explains quantitative analysis and the methods for the discovery of the typhoid bacillus, and the colon bacillus, and the value of these tests. General discussion follows. 11000 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44880 F.

Cleveland, Ohio.

The Cleveland Water Supply Tunnel. S. J. Pierce. Presents observations made and results shown during the construction of a tunnel under Lake Erie. Geological features. 1800 w. Am Geol—Dec., 1901. No. 44992 D.

Dams.

See Civil Engineering. Construction.

Detroit, Mich.

Recent Operating Experience in the Detroit Water Department. A statement from official reports of the cause of the very large draught on the Detroit waterworks, with the official suggestions for remedying it. 2100 w. Eng Rec—Dec. 21, 1900. No. 45000.

Distribution.

The Best Slope and Pipe Diameters for a Water Works Plant (Günstige Grabenneigung und Rohrweite bei Wasserkraft Anlagen). Dr. Ph. Forchheimer. A discussion of the effect of slope and cross section upon the efficiency of a water distribution system. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 15, 1901. No. 45166 B.

Filters.

The Efficiency of the East Providence Mechanical Filters. An explanation of the action of a half-million-gallon plant during a run of 20 months, the efficiency in removing color as well as bacteria being

given. 600 w. Eng Rec—Dec. 7, 1901. No. 44819.

Ground Water.

The Movement of Waters in the Earth (Wasserbewegung durch Boden). Ph. Forchheimer. A comparison of the results of various experimenters with the observed facts in nature. Two articles. 10000 w. Zeitschr d Ver Deutscher Ing—Dec. 7, 14, 1901. No. 45160 each D.

Inspection.

The Work of Sanitary Inspection on the Metropolitan Water Works. William W. Locke. Calls attention to the dangers to health where surface water works are in operation, and suggests some of the agencies through which pollution may be prevented. Also discussion. 3500 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44881 F.

Pipe Specifications.

Standard Specifications for Cast-Iron Pipe. An explanation of the principles adopted by a committee of the New England Water-Works Assn. in preparing standards for cast-iron pipe and specials. 1300 w. Eng Rec—Dec. 7, 1901. No. 44816.

Pollution.

River Pollution. Abstracts of papers, with the discussions, as presented to the conference on water supplies and river pollution. 8500 w. Jour Gas Lgt—Nov. 26, 1901. No. 44813 A.

The Pollution of Streams by Manufactural Wastes, and Methods of Prevention. H. W. Clark. Reports investigations upon the purification, or utilization of the wastes from industrial works, especially considering the wastes from woolen mills, tanneries, paper mills and silk mills. 5100 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44883 F.

Pumping Machinery.

See Mechanical Engineering, Hydraulics.

Reservoirs.

Clearing and Enlarging the Spot Pond Storage Reservoir, Metropolitan Water Supply. Caleb Mills Saville. Illustrated description of work to bring this reservoir in Massachusetts up to modern sanitary requirements. 3000 w. Eng News—Dec. 12, 1901. No. 44890.

Cleaning the Distributing Reservoirs of the Water-Works of Burlington, Vt. F. H. Crandall. Describes the work that is carried out twice each year. 900 w. Eng News—Dec. 12, 1901. No. 44893.

Railroading in a Reservoir. Fred H. Colvin. Illustrates and describes interesting features in the construction of Boston's work in connection with its new water supply. 1000 w. Loc Engng—Dec., 1901. Serial. 1st part. No. 44693 C.

The Needless Changes in the Jerome Park Reservoir Construction. Alfred Craven. An illustrated discussion. 2200 w. Eng News—Dec. 19, 1901. No. 44983.

Vermont.

Water Supplies of Vermont. Charles P. Moat. A statement of the conditions and the supplies, discussing the kind and quality of water furnished. 2700 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44884 F.

Water Power Failure.

Fall of the Fairhaven Water Tower. R. C. P. Coggeshall. Illustrations with an account of the disaster. 700 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44885 F.

MISCELLANY.

Abattoir.

The New Abattoir at Düsseldorf (Les Nouveaux Abattoirs de Dusseldorf). Describing especially the sterilizing and refrigerating plant. 1500 w. 1 plate. Génie Civil—Nov. 30, 1901. No. 45103 D.

Sanitation.

The Sanitation of a Country House. Max Clarke. Read before the British Archt. Assn. Discusses the sanitary requirements of houses, the drainage, foundations, walls, roofs, plumbing, sewage disposal, etc., etc. 11800 w. Builder—Nov. 23, 1901. No. 44710 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Africa.

The Cape to Cairo Telegraph. An illustrated article giving information in regard to the construction of the line. 1400 w. Sci Am—Nov. 30, 1901. No. 44648.

Cable Jubilee.

The Jubilee of Submarine Telegraphy. Reviews the first public employment of submarine telegraphy which took place fifty years ago—on November 13, 1851. 1500 w. Engr, Lond—Nov. 22, 1901. No. 44745.

Cables.

High-Tension Cables. Oscar Schaefer. Describes experiments made at the works of the Kabelwerk Duisburg, Germany, in August, 1897, discussing results. 2800 w. Elect'n, Lond—Nov. 22, 1901. No. 44717 A.

The German-American Cable (Das Deutsch-Amerikanische Kabel). A description of the Emden-Fayal-New York cable, including the instruments and method of operation. 3000 w. Electrotech Zeitschr—Dec. 5, 1901. No. 45201 B.

The Manufacture of Deep Sea Cables in America. Discusses points relating to the ability of the American manufacturer to make such cable, and the protection that should be afforded the industry. 2500 w. Elec Wld & Engr—Dec. 21, 1901. No. 45010.

Insulation.

The Determination of the Insulation Resistance of Telegraph Cables (Ueber die Bestimmung des Isolationuiderstandes von Telegraph kabeln). K. Strecker. Deriving curves from which the resistance can be deduced from a limited number of observations. 2000 w. Elektrotech Zeitschr—Nov. 14, 1901. No. 45191 B.

Leakage.

The Influence of Leakage upon Telephone Lines on Pupin's System (Ueber den Einfluss der Albeitung auf Oberirdische Vernsprechleitungen nach Pupin's System). Dr. F. Breisig. A mathematical analysis, showing the increased effect of leakage, and the necessity for superior insulation. 2000 w. Elektrotech Zeitschr—Dec. 12, 1901. No. 45204 B.

Police Telephone.

Police Department System Pan-American Exposition. Illustrated description of the interesting police system employed for official use by the police and guard departments, employing a telephone with a signalling apparatus. 1600 w. Telephony—Nov., 1901. No. 44701.

Space Telegraphy.

Marconi Signals Across the Atlantic. An account of the recent experiments made in signalling between St. Johns, Newfoundland. and Cornwall, England. Ill. 3000 w. Elec Wld & Engr—Dec. 21, 1901. No. 45011.

The Armstrong-Orling System of Wireless Telegraphy. Drawings, with brief explanatory extract, and unfavorable comment. 1000 w. Elec Engr, Lond—Dec. 6, 1901. No. 44913 A.

Speed Conversion.

Cable Speed-Rate Conversion Tables. E. Raymond-Barker. Presents a table of multipliers by which statements of telegraphic speeds, whether in siphon recorder or in Morse codes, may be reduced from one mode of expression to another with due regard always to the varying space factor. 1500 w. Elec Rev, Lond—Nov. 22, 1901. No. 44727 A.

Telephone Exchange.

Recent Common Battery Telephone Exchange Work in New York City. Herbert Laws Webb. An illustrated description of the recent conversion of the Cortlandt street district to common battery working. 4500 w. Elec Wld & Engr—Dec. 7, 1901. No. 44868.

The Economic Design and Management of Telephone Exchanges. Arthur V. Abbott. Notes from the experience of the writer concerning the economic design and management. The present article considers the factors in the problem of design. 2300 w. Elec Wld & Engr—Dec. 7, 1901. Serial. 1st part. No. 44869.

The National Telephone Co.'s New Telephone Exchange at Kensington. An illustrated detailed description of an exchange in England, typical of the latest practice. 2900 w. Elect'n, Lond—Dec. 6, 1901. Serial. 1st part. No. 44910 A.

The Post Office Telephone Exchange for the City of London. Illustrated detailed description of the central exchange in Carter-lane. 4200 w. Elec Engr, Lond—Dec. 6, 1901. No. 44912 A.

The Telephone Exchange Systems of the Maryland Telephone and Telegraph Company. Kempster B. Miller. An illustrated description of the system installed and the work that has been accomplished by this company. 2800 w. Elec Wld & Engr—Dec. 7, 1901. No. 44867

DISTRIBUTION.

Alternating Current.

Alternating Current as a Factor in General Distribution for Light and Power. Charles F. Scott. Considers whether for general distribution for lighting and power service it is desirable to utilize the current as alternating current or to convert it into direct current. 2000 w. Trans Am Inst Elec Engrs—Nov., 1901. No. 44678 D.

Notes on the Alternating Current System of Distribution. W. S. Barstow. Discusses the field of the alternating-current system and the requirements to enable it to enter the compact direct-current field. 1600 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44679 D.

Buffalo System.

The Buffalo High-Tension Cable Distribution System. Harold W. Buck. Illustrated description of this system and the methods employed. 1500 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44677 D.

Cities.

Distribution of Electrical Energy in Large Cities. Louis A. Ferguson. Describes the system employed in Chicago, and refers to similar systems in Europe. Recommends direct current for the lighting and power in the business and residence districts, and alternating current for

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the less closely built and suburban districts. 4000 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44675 D.

Distribution of Electricity in Cities of Moderate Size. William Lispenard Robb. Favors the three-wire, 220 volt system of direct current, in view of existing conditions, and discusses means of securing cheap production. 1800 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44681 D.

Faults.

Locating the Faults in Underground Distribution Systems. Henry G. Stott. Shows that with the large cables used in cities the application of the loop method is impracticable, and discusses three other methods, favoring the compass method. Ill. 1300 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44676 D.

Rotary Converters.

Rotary Converters. A. S. M'Allister. Concerning the satisfactory and economical operation. 2500 w. Am Elect'n—Dec., 1901. No. 44784.

The Operation of the Rotary Converter. D. B. Rushmore. Mr. Rushmore's second paper treats of the practical experiences met in the operation of the rotary converter, including starting, hunting, inversion, compounding, and speed control. 3500 w. Engineering Magazine—Jan., 1902. No. 45049 B.

Specifications.

Standard Specifications for the Installation of High Pressure Electrical Systems (Verschriften für die Errichtungen von Elektrischen Starkstromanlagen). The full text of the specifications proposed by the German Electrotechnical Society. 9000 w. Electrotech Zeitschr—Nov. 21, 1901. No. 45194 B.

Switches.

Connecting and Disconnecting Switches (Les Conjoncteurs-Disjoncteurs). G. Fiévé. Describing special forms of switches used in connection with the charging of accumulators and with the operation of dynamos in parallel. 4500 w. Mem Soc Ing Civ de France—Oct., 1901. No. 45123 G.

Three-Phase.

The Distribution of the Three-Phase System and the Operation of Single-Phase Circuits by It. W. L. R. Emmet. Favors the use of three-phase machines in general for alternating-current generation in central stations, even when the distribution is single-phase. 2500 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44680 D.

Three-Wire.

250-500 Three-Wire Distribution for Lighting and Power. Phillippo Torchio. Advocates the use of the three-wire, 500-volt system, discussing its advantages, and means of overcoming difficulties. 2500 w. Trans Am Inst of Elec Engrs—Nov., 1901. No. 44682 D.

Underground Cables.

Inadvisability of Placing High and Low Potential Wires Through the Same Conduits or Through the Same Manholes. William Brophy. Read before the International Assn, of Munic. Elect'ns. Briefly describes the two underground systems in use, and discusses plans and methods for placing all wires underground, recommending the system adopted by the Massachusetts legislature. 3400 w. Elec Rev, N. Y.—Nov. 30, 1901. No. 44673.

The Practicability of Placing High and Low-Potential Wires in Separate Ducts in a Combined Conduit System. Charles F. Hopewell. A reply to an article by William Brophy. Discusses methods of construction and operation, and what is a safe distance for the separation. 2500 w. Elec Rev, N. Y.—Dec. 21, 1901. No. 45014.

Wiring.

Interior Wiring. Describes methods and gives tables for computing. 2000 w. Am Elect'n—Dec., 1901. No. 44790.

ELECTRO-CHEMISTRY.

Chlorates.

The Electrolytic Production of Chlorates. John B. C. Kershaw. Describes the cell used by the National Electrolytic Co., of Niagara Falls. Ill. 1700 w. Elect'n, Lond—Dec. 13, 1901. No. 45027 A.

Edison Cell.

Theory of the Edison Nickel-Iron Cell. E. F. Roeber. Discusses the communication of Mr. Woolsey McA. Johnson, published in this magazine of Nov. 2, objecting to the conclusions. 2000 w. Elec Wld & Engr—Dec. 7, 1901. No. 44870.

Electro-Metallurgy.

Electrometallurgy in 1900 (L'Electrométallurgie en 1900). Paul Chalon. Reviewing especially the work of the electric furnace and its practical applications during 1900. 6000 w. 1 plate—Rev Univ des Mines—Nov., 1901. No. 45126 H.

Storage Batteries.

Storage Batteries on Electric Systems. Harold Seaman. Discusses the operation of the cells or units which make up the battery and its operation as a whole. 3500 w. Wis Engr—Dec., 1901. No. 44995 C.

ELECTRO-PHYSICS.

Accumulators.

The Losses of Energy in Accumulators. B. Hopkinson. A description of experiments made to ascertain definitely what the efficiency under different conditions might amount to. 2500 w. Elect'n, Lond—Nov. 29, 1901. Serial. 1st part. No. 44849 A.

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Dielectrics.

Dielectric Constant of Paraffins. Will G. Hormell. Presents some experiments in which by means of a modified form of the Blondlot oscillator the dielectric constants of four commercially different paraffins were obtained for 40, 60, and 80 centimeter waves. Also other investigations of interest. Ill. 4000 w. Am Jour of Sci—Dec., 1901. No. 44674 D.

Induction.

Air-Gap Induction. F. W. Carter. A contribution to the subject of the distribution of magnetic flux over the surface of a tooth-cored armature, giving the solution of an ideal problem devised to resemble very nearly that of the magnetic flux between a smooth pole face and a toothed armature. Also editorial. 4200 w. Elec Wld & Engr—Nov. 30, 1901. No. 44695.

Radiography.

Studies Upon Radium (Etudes sur le Radium). M. Berthelot. With especial reference to the chemical properties of the new element radium. A paper before the French Academy. 1800 w. Comptes Rendus—Dec. 9, 1901. No. 45134 D.

The Radio-Activity Induced by the Salts of Radium (Sur la Radio-Activité Induite Provoqué par des Sels de Radium). P. Curie and A. Debierne. Describing the latest experiments showing the power of the salts of radium to induce fluorescence and phosphorescence. 1200 w. Comptes Rendus—Dec. 2, 1901. No. 45133 D.

The Radio-Activity of Uranium (Sur la Radioactivité de l'Uranium). A review of the observation which led to the discovery of the radio-active properties of uranium, with data as to the most recent experiments. 1500 w. Comptes Rendus—Dec. 9, 1901. No. 45135 D.

GENERATING STATIONS.

Alternators.

Alternators With Dampers. J. Fischer-Hinnen. Deals with the theory of copper loops linked with the field circuits of alternating current machines, on the basis of the theory of induction motors. Ill. 4400 w. Elec Wld & Engr—Dec. 28, 1901. No. 45066.

Artificial Loading of Alternating-Current Machinery. Rudolf Goldschmidt. Translated from the *Elektrotechnische Zeitschrift*. Discusses the heating of alternators, and methods of loading. Ill. 1800 w. Elec Engr, Lond—Dec. 13, 1901. No. 45029 A.

Experiments on Periodic Variations Occurring in the Exciting Current of an Inductor Alternator. W. Duddell and E. W. Marchant. A report of experimental investigations of the nature and magnitude of this induced alternating current in the field of an inductor alternator, in which the variation was known to be considerable. 1800 w. Elect'n, Lond—Nov. 29, 1901. Serial. 1st part. No. 44850 A.

Battery Connections.

The Proportions of Battery Connections (Dimensionirung von Zellenschalterleitungen). Discussing the most economical arrangement of accumulator cells and their connections, developing diagrams for practical use. 3000 w. Elektrotech Zeitschr—Dec. 5, 1901. No. 45200 B.

Central Station.

A Model Small Central Station. C. W. Obert. An illustrated description of the municipal lighting plant at Wappinger's Falls, N. Y. 1900 w. Am Elect'n—Dec., 1901. No. 44783.

Commutators.

The Commutation of Currents (Zur Theorie der Stromwendung). K. Pichelmayer. A brief mathematical examination of the conditions necessary to avoid sparking of commutators. 1000 w. Elektrotech Zeitschr—Nov. 21, 1901. No. 45193 B.

Compounding.

The Compounding of Alternators (Compoundirung von Wechselstromgeneratoren). A. Heyland. Discussing the arrangement of synchronous and non-synchronous generators, with diagrams showing the armature reactions. 3000 w. Elektrotech Zeitschr—Dec. 12, 1901. No. 45202 B.

Generating Sets.

Horizontal Engines and Dynamos of 3000 Horse Power (Horizontale Dampfdynamomaschinen vonje 3000 P. S.). Illustrated description of the Sulzer engines and A. E. G. dynamos in the Moabit station in Berlin. 2000 w. 1 plate. Schweizerische Bauzeitung—Dec. 7, 1901. No. 45178 B.

Standardization of Direct-Connected Engines and Dynamos. An illustrated report to the Am. Soc. of Mech. Engrs. 2000 w. Eng Rec—Dec. 7, 1901. No. 44821.

Hydro-Electric Plant.

Notes on Hydro-Electric Development Recently Completed Near Guadalajara, Mexico. M. A. Viele. Brief description. 700 w. Eng & Min Jour—Dec. 14, 1901. No. 44948.

The Electric Power Stations of the Fayet-Chamonix Railway (Les Usines Electriques du Chemin de Fer du Fayet à Chamonix). E. Javaux. Describing the two hydraulic stations near Chatelard in the French Alps (Haute Savoie). 2500 w. Mem Soc Ing Civ de France—Oct., 1901. No. 45122 G.

The Montgomery, Alabama, Water Power Plant. Illustrates and describes a

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plant for generating 5000 H. P. and transmitting it electrically, to be used for lighting and power purposes. 2000 w. Eng News—Dec. 5, 1901. No. 44793.

The Truckee River Electric Power Plant. Illustrated description of the hydraulic station at Floriston, Cal., where electricity is generated for use in the Comstock mines, 30 miles distant. 1500 w. Eng Rec—Dec. 14, 1901. No. 44936.

The Water Power Plant at Hannawa Falls, N. Y. From a paper by W. C. Johnson, read before the Am. Soc. of Mech. Engrs., with additional illustrations. Describes a plant for developing an 85-ft. fall on the Raquette River. 3200 w. Eng Rec—Dec. 7, 1901. No. 44820.

Isolated Plants.

The Economy of Isolated Electric Plants. Isaac D. Parsons. A Methodical study of the actual working costs of existing plants, showing the conditions under which isolated plants are advantageous. 4500 w. Engineering Magazine—Jan., 1902. No. 45046 B.

The Electric Plant at the Goldsmiths' Institute. Illustrates and describes an electric lighting plant which also provides current for educational and experimental purposes in the laboratory. 1000 w. Engr, Lond—Dec. 6, 1901. No. 44923 A.

Lighting Station.

The Bay Ridge Station of the Edison Electric Light Co. of Brooklyn. Illustrated description of the new installation of vertical engines. Calls attention to the rapid development in electric stations, as illustrated by the installation less than four years ago of 3000 h. p. double horizontal tandem compound direct-connected alternating current unit. 3000 w. Power —Dec., 1901. No. 44958.

Magnet Poles.

The Influence of Pole Arrangement Upon the Performance of Dynamos (Beurtheilung der Eigenschaften von Dynamomaschinen auf Grund der Nuthenanordung). Dr. M. Corsepins. A long analytical examination of the effects of pole arrangements with practical examples. Three articles, 10,000 w. Elektrotech Zeitschr—Nov. 18. Dec. 6, 12, 1901. No. 45197 each B.

Power House.

The Country Power Station at Crottorf, Saxony (Die Hochspannungs-Ueberland centrale. Crottorf i S.). Dr. Richard Apt. A description of an electric power station for the generation and distribution of power to country users. 3000 w. Elektrotech Zeitschr—Nov. 28, 1901. No. 45,196 B.

Salford, Eng.

The Electricity Works of the Salford Corporation. Illustrated description of new works to furnish current for lighting and power. 3600 w. Engng—Dec. 13. 1901. Serial. 1st part. No. 45041 A.

Small Stations.

Stations for Electric Supply of Small Districts (Centraal stations voor Electrische Stroom levering in Klemere Gemeenten). C. D. Nagtglas Versteeg. Giving data of a number of moderate sized stations in Holland, and a description of the plant at Hilversum. 3000 w. De Ingenieur—Nov. 23, 1901. No. 45206 D.

Synchronism.

A New Synchronism Indicator for Alternators. Fred P. Woodbury. Illustrates and describes an instrument, invented by Paul M. Lincoln. 500 w. Sci Am—Dec. 7, 1901. No. 44767.

Tariffs.

Reform in the Charges of Electric Works (Vorschläge zur Tarifreform der Elektricitätswerke). K. Wilkens. Discussing rational formulas upon which proper charges for electrical energy supply may be based. 2000 w. Elektrotech Zeitschr—Dec. 5, 1901. No. 45199 B.

LIGHTING.

Arc Lights.

Changes in Arc Lighting. Alton D. Adams. A statistical review of arc-lighting in Massachusetts, showing the changes that have taken place. Also editorial. 3300 w. Elec Wld & Engr—Nov. 30, 1901. No. 44696.

Some Brush Arc-Light Dynamo Troubles and Their Remedies. F. B. O'Hanlon. Points from the experience of the writer. 1200 w. Am Elect'n—Dec., 1901. No. 44,791.

Department Store.

Electricity in a Newark, N. J., Department Store. Illustrates and describes the arrangements for lighting which are said to be the best in the country. 2000 w. Elec Wld & Engr—Dec. 14, 1901. No. 44953.

Exposition.

Electricity at the Charleston Exposition. Charles T. Malcolmson. Describes the arrangements being made for power and lighting. Ill. 1400 w. Elec Wld & Engr —Dec. 14, 1901. No. 44952.

Lamps.

The Crawford-Voelker Incandescent Electric Lamp. F. Q. Maguire. Describes a new carbide of titanium lamp which it is said can be made with an efficiency of 2.3 watts per candle at 100 volts and for pressures up to 500 volts. Also extracts from report of tests. 2000 w. Elec Rev, Lond—Dec. 6, 1901. No. 44914 A.

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Lighting Station.

See Electrical Engineering, Generating Stations.

Nernst Lamps.

Tests of Nernst Lamps. Translation of an article by Prof. W. Wedding, in a recent number of *Elektrotechnische Zeitschrift*, giving results of some experiments with Nernst lamps of different models, manufactured by the Allgemeine Electricitäts-Gesellschaft. 1200 w. Elec Engr, Lond—Nov. 22, 1901. Serial. 1st part. No. 44719 A.

Staten Island, N. Y.

Lighting and Railway Development on Staten Island. Max Lowenthal. Illustrated description of the New York & Staten Island Electric Company's system. History of the consolidation is given. 3000 w. Elec Wld & Engr—Dec. 28, 1901. No. 45065.

MEASUREMENT.

Permeameter.

A Direct-Reading Permeameter. Prof. F. G. Baily. Read before the British Assn. at Glasgow. Illustrates and describes the instrument and explains its use. 2000 w. Elect'n, Lond—Nov. 22, 1901. No. 44716 A.

A Permeameter for Testing the Magnetic Qualities of Materials in Bulk. Charles V. Drysdale. Read before the Inst. of Elec. Engrs., England. Illustrates and describes an apparatus for iron-testing, explaining methods and the principles involved. 4200 w. Elect'n, Lond—Dec. 6, 1901. No. 44911 A.

The Measurement of the Slip of Asynchronous Motors by the Stroboscopic Method (Messung der Schlüpfung Asynchroner Motoren nach der Stroboskopischen Methode). A. Schweitzer. Showing the manner in which Braun's tube may be used instead of the arc lamp, as described by Beniscke. 1000 w. Elektrotech Zeitschr—Nov. 14, 1901. No. 45190 B.

Slip Counter.

A Mechanical Slip Counter for Non-Synchronous Motors (Ein Mechanischer Schlüpfungszähler fur Asychronmotoren). E. Ziehl. A combination of a differential speed indicator and a small standard synchronous motor. 1800 w. Elektrotech Zeitschr—Dec. 12, 1901. No. 45203 B.

Testing.

The Stray Power Method of Testing Direct-Current Motors and Generators. William Lincoln Smith. Calls attention to the advantages of this method of testing the efficiency of direct-current machines. 1300 w. Elec Wld & Engr—Dec. 14, 1901. No. 44954.

Voltmeter.

A Simple Method of Calibrating a Voltmeter. J. Rowland Brown. An explanation of method, with diagram. 500 w. Am Elect'n—Dec., 1901. No. 44787.

POWER APPLICATIONS.

Berlin.

The Users of Electricity at Berlin. Reports the rapid development of electricity as applied to the various purposes of power and illumination, especially the phenomenal development of electrical tramways. 1000 w. U S Cons Repts, No. 1206—Dec. 5, 1901. No. 44748 D.

Cranes.

Notes on Crane Design. A. D. Williams. Discusses points in the design of electric cranes and their motors. 1300 w. Am Mach—Nov. 28, 1901. No. 44642.

125-Ton Four-Motor Overhead Electric Traveller. Sectional illustrations, with details embodying many new features and description. 1400 w. Engr, Lond—Nov. 29, 1901. No. 44862 A.

Electric Driving.

Electric Power in Carriage Works. Ernest D. Phillips. An illustrated description of the electric power plant recently installed in these reconstructed works at Saltley, near Birmingham, Eng. 4000 w. Engng—Dec. 13, 1901. No. 45039 A.

The Electrical Operation of Modern Machine Tools and Machines. Robert T. Lozier. Read before the N. Y. Elec. Soc. Shows what has been accomplished in overcoming the disadvantages of the entire belting system, and removing the objectionable features of the individual motor. Ill. 3000 w. Elec Rev, N. Y.—Dec. 21, 1901. No. 45013.

Elevator.

Self Contained Electric Elevator (Automobile Elektrische Aufzüge). A description of the Wüst system, in which the motor and winding mechanism is carried on the car. 1000 w. Glasers Annalen—Dec. 1, 1901. No. 45174 D.

Mine Power.

Electric Power in Mining (Elektricität im Grubenbetriebe). A general review of the advantages of electric driving in mining, with examples of successful practice. 1200 w. Glasers Annalen—Dec. 1, 1901. No. 45173 D.

German Electric Plants. Illustrates and describes an example of the slow-speed three-phase electric motor now extensively used for driving pumps in mines in Germany, and the accessory plant on the surface in connection with the system. 2500 w. Engr, Lond—Nov. 22, 1901. No. 44744 A.

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Motor Diagrams.

The Numerical Computation of Three-phase Motor Diagrams (Ein Beitrag zur Rechnerischen Behandlungen des Dreiphaser-Motordigrammes). O. Weisshaar. An analytical treatment of the data from motor diagrams, with applications to numerical examples. 4000 w. Elektrotech Zeitschr—Nov. 14, 1901. No. 45189 B.

Motors.

The Performance of Electric Railway Motors. George T. Hanchett. Gives an analysis of performance curves and considers their application to the problem of practical selection, believing it to be the only proper way of choosing a railway motor for a given service. 5000 w. St. Ry Jour—Dec. 7, 1901. No. 44835 D.

Navy Yard.

Electricity at the New York Navy Yard. F. N. Kollock, Jr. An illustrated description of the new polyphase power plant. 8800 w. Jour Am Soc of Nav Engrs—Nov., 1901. No. 44641 H.

Pumping Machinery.

The De Kalb Electrical Pumping Plant. D. W. Mead. Illustrated description of a municipal plant in Illinois which has been in successful operation since February, 1895. 3000 w. Munic Engng—Dec., 1901. No. 44756 C.

MISCELLANY.

Address.

Sir William Henry Preece's Address before the Society of Arts. The subject discussed was the great scientific discoveries of the 19th century. 10700 w. Jour Soc of Arts—Nov. 22, 1901. No. 44707 A.

Arresters.

Notes on Lighting and High Voltage Arresters for Electric Currents. J. Wright. Considers how to efficiently protect a building from lightning, and also electric circuits not connected to earth. Ill. 2700 w. Ind & East Engr—Nov, 1901. No. 45036 B.

Electrical Instruments.

Notes on Practical Electrical Instrument making. John C. Bagot. An illustrated article touching on points needing to be understood by instrument makers, that comprehending the effect to be produced, he can manufacture the cause. 1700 w. Elec Engr, Lond—Nov. 22, 1901. Serial. 1st part. No. 44721 A.

Lightning.

Lessons from Lightning Strokes (Blitzschläge und Lehren aus Denselben). F. Neesen. A discussion of the recorded action of lightning strokes and a consideration of possible short circuits and other sources of danger. 1800 w. Elektrotech Zeitschr—Nov. 28, 1901. No. 45198 B.

The Effect of Lightning upon Metallic Structures (Les Constructions Métalliques et la Foudre). A review of the records of skeleton steel buildings which have been struck by lightning, discussing the possible relation between the construction and effect. 1200 w. Revue Technique—Nov. 10, 1901. No. 45110 D.

GAS WORKS ENGINEERING

Acetylene.

Car Lighting by Acetylene Gas on the Avery Acetylite System. Illustrates and describes the apparatus and its connections as used on cars. 900 w. Eng News—Dec. 5, 1901. No. 44797.

Incandescent and Carburetted Acetylene. Reviews a paper presented by Dr. N. Caro, to the German Acetylene Verein. Discusses the difficulties in the way of making a satisfactory burner, and the properties of acetylene. 1200 w. Engr, Lond—Dec. 13, 1901. No. 45044 A.

Coal Handling.

The Mechanical Handling of Coal and Coke (Manutention Mécanique du Charbon et du Coke). J. Laverchère. Describing and illustrating very fully the apparatus used at the gas works of Dijon and of Havre. 2000 w. 1 plate. Génie Civil—Dec. 7, 1901. No. 45105 D.

Exhibition.

The Gas Exhibition at the Crystal Palace. A review of the exhibits. 7700 w. Jour Gas Lgt—Dec. 17, 1901. No. 45072 A.

Gasholders.

Mayer's Improvements in Gasholder Tanks. Illustrations and specifications. The construction is the same as the Intze gasholder save that the Mayer tank is not an annular one. 1200 w. Am Gas Lgt Jour—Dec. 9, 1901. No. 44839.

Gas Plants.

The Efficient Working of Gas Plants for Gas Engines. Joseph Emerson Dowson. From the minutes of Pro. of the Inst. of Civ. Engrs., England. Discusses some of the theoretical and practical considerations which affect the working. 3800 w. Eng News—Dec. 5, 1901. No. 44798.

Gas Producers.

The Action of Various Types of Gas

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Producers (Sur l'Action des Divers Types de Gazogènes). A. Lencauchez. With especial reference to the action of producer gas in open-hearth furnaces. 4000 w. Mem Soc Ing Civ de France—Sept., 1901. No. 45120 G.

Generator.

Gas Generator with Reversed Combustion. J. Deschamps, in *Le Genie Civil.* Illustrates and describes an apparatus that has been in use for several months in France for supplying gas motors. 1500 w. Sci Am Sup—Dec. 7, 1901. No. 44770.

High Pressure.

High-Pressure Gas Lighting. Mr. Casmey, before the Manchester and Dist. Junior Gas Assn. Describes the Keith compressor and burner, comparing it with the incandescent and common gas-jet. Discussion. 4000 w. Jour Gas Lgt—Dec. 3, 1901. No. 44888 A.

Illumination.

The Physical Principles of Illumination, with Special Reference to Recent Methods. Douglass Burnett. Presented to the Department of Physics, of the Brooklyn Inst. A review of basic scientific principles, existing methods and future possibilities. 3500 w. Am Gas Lgt Jour—Dec. 23, 1901. No. 45009.

Mantles.

Testing Incandescent Mantles. Abridged rules issued by the German Gas Association. 1000 w. Gas Wld—Dec. 14, 1901. No. 45025 A.

Measurement.

Quick Measurement and Analysis of Gas. Dr. Hugo Strache. Read before the German Gas Assn. Describes the author's developments, the instruments used, etc. 2200 w. Gas Wld—Nov. 23, 1901. No. 44715 A.

Retorts.

Heckmondwick Inclined Retorts and Coal and Coke Plant. Describes a very complete installation and its accompaniments. 3300 w. Jour Gas Lgt—Dec. 10, 1901. No. 44975.

The Economical Advantages of Inclined Retort-Settings. W. R. Herring. An examination of statistics abstracted from "Field's Analysis" and a statement of conclusions. 2500 w. Jour Gas Lgt—Dec. 3, 1901. No. 44886 A.

Wakefield.

The Wakefield Gas-Works. H. Townsend. Read before the Manchester Dist. Inst. of Gas Engrs. History of the gas works, with illustrated description of the inclined retorts. Also discussion. 11200 w. Jour Gas Light—Dec. 3, 1901. No. 44887 A.

Water Gas.

Carburetted Water Gas. From *Le Genie Civil.* An illustrated sketch of this industry. 3300 w. Sci Am Sup—Dec. 14, 1901. No. 41908.

Water-Gas Tar.

Water-Gas Tar for Boiler Heating. Illustrated description of the system as used by the Hodroleum Company. 1800 w. Jour Gas Lgt—Nov. 26, 1901. No. 44812 A.

Wood Gas.

The Riche Wood Gas Process. Illustrated detailed description. 1300 w. Ir & Coal Trds Rev—Nov. 22, 1901. No. 44736 A.

INDUSTRIAL ECONOMICS

Africa.

Need of Direct Steamship Service to Africa. Criticises the methods of American manufacturers in introducing their products where the English language is not understood, explains European methods, and discusses the need of American steamships. 3500 w. U S Cons Repts, No. 1209—Dec. 9, 1901. No. 44774 D.

Alcohol.

Exposition of Motors and Appliances for Utilizing Methylated Alcohol (Concours et Exposition de Moteurs et Appareils Utilisant l'Alcool Denaturé). H. Guérin. An account of the exposition in Paris for the purpose of promoting the industrial applications of alcohol. Two articles. 4000 w. Génie Civil—Dec. 7, 14, 1901. No. 45106 each D.

Competition.

British and American Fuel: Is Competition Possible? Considers the whole problem hinges on the question of freights, and discusses this side of the question in some detail. 3700 w. Ir & Coal Trds Rev—Dec. 6, 1901. No. 44915 A.

The Invasion of British Markets (L'Invasion du Marché Britannique). A report of the French consul M. Jean Perier, concerning the extent to which American products have entered into British trade. Serial, Part I. 3000 w. Revue Technique —Nov. 25, 1901. No. 45116 D.

Exposition.

The Exposition of 1902 in Düsseldorf (Die Austellung in Düsseldorf 1902). E. Dücker. A general description, with views of the buildings as thus far completed. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 23, 1901. No. 45153 D.

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Factory Legislation.

The Factory and Workshop Act, 1901. A short account of the whole act, which has recently passed the British Parliament, emphasizing the portions which are new. 5000 w. Engng—Dec. 13, 1901. No. 45-038 A.

Industrial Commission.

The Three-Year's Work of the United States Industrial Commission. Samuel M'Cune Lindsay. This commission was established to investigate questions pertaining to immigration, labor, agriculture and business, and to suggest legislation as it deemed best on these subjects. 7000 w. Rev of Revs—Dec, 1901. No. 44705 C.

Industrial Forces.

A New Alignment of Industrial Forces. J. B. Johnson. Discusses the changed attitude of union leaders and trade unionism in general. 2100 w. Am Mfr—Dec. 19, 1901. No. 45008.

Patents.

General Information Concerning Patents for Inventions (Renseignments Généraux Relatifs aux Brevets d'Invention). A tabulated presentation of the essential requirements for patents in 17 important countries of Europe and America. 1200 w. Revue Technique—Nov. 25, 1901. No. 45115 D.

Purchasing.

The Card Index System in the Purchasing Department. F. H. Leland. Describes a card index system adapted to the requirements of the purchasing department of a manufacturing company. 2400 w. Am Mach—Nov. 28, 1901. No. 44643.

Ship Subsidy.

The New Ship Subsidy Bill. Full text of the revised measure as introduced to the Senate of the United States. 2200 w. Naut Gaz—Dec. 12, 1901. No. 44897.

Shop Economics.

Neglected Factors in Machine-Shop Economics. T. S. Bentley. Discussing the importance of providing shop conveniences, the economic value of light and warmth, and the general advantages of system and method in every department. 2500 w. Engineering Magazine—Jan., 1902. No. 45-051 B.

Unions.

Employers and Labor Unions. Abstract of an address by Mr. George Gunton before the Manufacturers' Club of Cincinnati. Discusses the relations of the employer and employed, and suggests means of adjusting difficulties. 4200 w. Gunton's Mag—Dec., 1901. No. 44747 C.

Workingmen's Homes.

The Home Environment of British Workingmen. Percy Longmuir. An examination of the important relation which home environment bears to industrial efficiency, and the extent to which deficiencies in this respect act as a handicap to British industries. 3500 w. Engineering Magazine—Jan., 1902. No. 45053 B.

MARINE AND NAVAL ENGINEERING

Armor.

Armor Plate and High Explosive Shells. Illustrations of tests made at Sandy Hook Proving Ground on the powers of defense and attack. 1200 w. Sci Am—Dec. 14, 1901. No. 44905.

Battleships.

I. Battleships "Kearsarge" and "Kentucky." II. Alabama Class—First-Class Battleship "Wisconsin." III. Maine Class—First-Class Battleship "Maine." Illustrated detailed descriptions, with discussion of novel features. 5800 w. Sci Am—Dec. 14, 1901. No. 44902.

Our Latest Design for Battleships. An illustrated description of plans recommended by the Naval Board on Construction. 1200 w. Sci Am—Nov. 30, 1901. No. 44651.

Russian Battleship Kniaz Potemkin Tavritschesky. Illustrated description of the vessel and its armament. 1400 w. Engr, Lond—Nov. 29, 1901. No. 44859 A.

Convention.

The Third Convention of the Society of Marine Architects (Die Dritte Hauptversammlung der Schiffbautechnischen Gesellschaft). A report of the meeting of German Marine Architects held at Charlottenburg, November, 1901. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1901. No. 45158 D.

Corrosion.

Notes on the Serious Deterioration of Steel Vessels from the Effects of Corrosion. George Johnstone. Lecture delivered at the opening meeting of the Inst. of Engrs. & Shipbuilders in Scotland, 1901. A record of the writer's experience. 3000 w. Naut Gaz—Dec. 19, 1901. No. 45015.

Cruisers.

I. Armored Cruisers of the "Maryland" Class—"California." II. The Semi-Armored Cruisers of the "St. Louis" Class. III. The Sheathed Semi-Protected Cruisers

We supply copies of these articles. See page 811.

of the "Denver" Class. Illustrated discussion of these vessels, noting features of special interest. 2500 w. Sci Am—Dec. 14, 1901. No. 44906.

H. M. First-Class Cruiser Monmouth. Illustration, with brief description of a recently launched vessel. 700 w. Engr, Lond—Nov. 22, 1901. No. 44746 A.

Destroyers.

Torpedo-Boat Destroyers. Editorial review of a recently issued Parliamentary paper giving information of the various torpedo-boat destroyers which have been built for the British Admiralty. 1600 w. Engng—Nov. 29, 1901. No. 44853 A.

Guns.

Gun Explosions. Discusses briefly the cause of gun accidents. 1900 w. Engr, Lond—Nov. 22, 1901. No. 44743 A.

I. Latest Types of Naval Guns. II. Gun Mounts and Breech Mechanisms. Illustrated detailed descriptions of the guns and their action. 2000 w. Sci Am—Dec. 14, 1901. No. 44904.

Lake Steamer.

Lake Steamer Captain Thomas Wilson. An illustrated description of a single deck bulk cargo steamer and its equipment. 1500 w. Marine Engng—Dec., 1901. No. 44866 C.

Lightships.

Recent Improvements in the Lighting and Buoying of the Coasts of France. Baron Quinette de Rochemont. Extract from a paper read before the Glasgow Congress. Describes the "Sandettie" lightship and accessories. 1400 w. Marine Engng—Jan., 1902. No. 45252 C.

Mercantile Marine.

The French Mercantile Marine. A statement of the decadence and present condition, and the difficulties in the attempts at revival. 2900 w. Engr, Lond—Dec. 6, 1901. No. 44920 A.

Monitors.

"Arkansas" Class—The Monitor "Arkansas." Illustrated description, with comments. 1200 w. Sci Am—Dec. 14, 1901. No. 44903.

Navy Yard.

See Electrical Engineering, Power Applications.

Oil Transportation.

The Carriage of Oil in Bulk. Describes the steamship Clam, one of a fleet of vessels used in the oil-carrying trade. The boilers are worked with oil instead of coal. The boat contains a number of well holds, and is capable of stowing away 4500 tons of oil. Some of the vessels will hold 11,000 tons. The vessels can be so cleansed as to carry the most delicate cargoes without taint. 1400 w. Engr, Lond—Dec. 6, 1901. No. 44926 A.

River Steamer.

Light-Draft River Steamer. Illustration and description of the Thomas A. Edison, built for service on the Caloosahatchee in Florida. 800 w. Naut Gaz—Dec. 12, 1901. No. 44896.

Schooners.

The Mechanical Equipment of Modern Schooners. B. C. Tuthill. The Geo. W. Wells is illustrated and described as a type of the large six-masted schooners, the method of fitting out being practically the same in the latest built schooners of large size. 1500 w. Marine Engng—Jan., 1902. No. 45250 C.

Shipbuilding.

The Works of the New York Shipbuilding Company. Illustrated detailed description of this fine plant on the Delaware River, opposite Philadelphia. 4500 w. Marine Engng—Dec., 1901. No. 44864 C.

Ship Subsidy.

See Industrial Economics.

Stability.

Stability of Ships. Theodore Incas. Discusses methods of measuring the stability, means of increasing the leverages, as well as the range of the stability, etc. Ill. 2200 w. Naut Gaz—Dec. 5, 1901. No. 44810.

Steamship.

Express Steamship La Savoie. Illustrated description of a fine new ship recently placed in service between New York and Havre. 900 w. Marine Engng—Dec., 1901. No. 44865 C.

Torpedo Boats.

I. The Holland Submarine Torpedo Boat Class. II. Torpedo Boats and Destroyers. Illustrated discussions with descriptions. 1700 w. Sci Am—Dec. 14, 1901. No. 44907.

U. S. Navy.

Our Naval Development Since the War with Spain. Description and illustrations of ships commissioned, completed or under construction since the war. Also editorial. 1500 w. Sci Am—Dec 14, 1901. No. 44901.

Warships.

The Gun Power of Warships. Editorial discussion of the increase in gun power and the placement of the guns. Compares British and American practice. 1800 w. Engng—Nov. 22, 1901. No. 44741 A.

Wharf Cranes.

The Development of Shipyard Crane Service. Henry P. Jones. An illustrated discussion of those cranes used in carrying on the work at the fitting-out wharf. 2500 w. Eng News—Nov. 28, 1901. No. 44656

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MECHANICAL ENGINEERING

AUTOMOBILES.

Boilers.

Automobile Boilers. Joseph W. Jones. States the principal requirements of a carriage boiler, and discusses the design and recent improvemnts. 2300 w. Horseless Age—Dec. 18, 1901. No. 44969.

Celebration Run.

The Celebration Run to Southsea. An illustrated account of the run made to celebrate the sixth anniversary of the passing of the Locomotive on Highways Act, 1896, in England. 5800 w. Autocar—Nov. 23, 1901. No. 44712 A.

Cycle Shows.

The Cycle Shows. Comments on the exhibits, and the tendency toward mechanical propulsion. Describes some of the most interesting cycles. 2500 w. Engng—Dec. 6, 1901. No. 44932 A.

Electric Power.

Electric Automobiles—Long Runs on One Charge. Henry F. Joel. An examination of some of the record or limit runs. 2000 w. Elec Rev, Lond—Nov. 22, 1901. No. 44726 A.

Engine.

The Stearns Compound Engine. Sectional view and description of the engine used on carriages manufactured in Syracuse, N. Y. 700 w. Horseless Age—Nov. 27, 1901. No. 44671.

Exhibits.

The National and Stanley Shows. Brief Illustrated descriptions of special features in the exhibits of motor cars, motor bicycles and their accessories. 4400 w. Auto Jour—Dec., 1901. No. 45071 A.

French Models.

General Characteristics of French 1902 Models. L. D. Makes a classification of the pleasure vehicles and investigates each class. 2800 w. Horseless Age—Dec. 4, 1901. Serial. 1st part. No. 44766.

Gasoline Motors.

Why Gasoline Motors Stall by Overheating. A. M. Herring. Discusses this subject and the methods of overcoming the trouble. 1200 w. Horseless Age—Dec. 18, 1901. No. 44967.

Hill Climbing.

The Gaillon Hill-Climbing Trials. An account of the annual trials in France, where seventy vehicles competed. Ill. 1600 w. Autocar—Nov. 23, 1901. No. 44711 A.

Military Vehicles.

Competition for Military Traction in Great Britain. A copy of the regulations governing a competition to be held in the spring of 1903. 2000 w. U S Cons Repts, No. 1211—Dec. 11, 1901. No. 44814 D.

Military Lorries. An account of the opening proceedings of the trials of self-propelled lorries for military purposes, with illustrated description of the Thornycroft vehicles. 3800 w. Engng—Dec. 6, 1901. No. 44930 A.

The Military Self-Propelled Wagon Trials. Illustrates and describes the wagon and trailer of the Straker Steam Vehicle Co. and other vehicles. 700 w. Engng—Dec. 13, 1901. No. 45037 A.

War Office Heavy Motor Vehicle Trials. Gives details of specifications supplied by the manufacturers entering vehicles. Ill. 4500 w. Auto Jour—Dec., 1901. No. 45070 A.

Motor Cycle.

Colonel Holden's Motor Bicycle. Detailed drawings and description of the most recent form of this machine. 2400 w. Auto Jour—Dec., 1901. No. 45069 A.

The Evolution of the Motor Cycle. Hrolf Wisby. Illustrates and describes developments of this machine. 1800 w. Sci Am—Dec. 21, 1901. No. 44974.

Speed Records.

New Automobile Speed Records. An account of the speed tests on Ocean Parkway, Brooklyn, on Nov. 16, 1901, with illustration of the automobile that made a mile in 63 seconds. 800 w. Sci Am—Nov. 30, 1901. No. 44652.

Stages.

A Novel Method of Motor Traction. Illustrated description of a system described by Herr Max Schiemann in the *Elektrotechnische Zeitschrift*. The novelty consists in supplying energy to the motor cars from trolley wires, though no tracks are provided. 900 w. Elec Engr, Lond—Dec. 13, 1901. No. 45028 A.

Electric Automobile Stages in New York City. Illustrates and describes the vehicles in service on Fifth avenue, New York. 1300 w. Elec Wld & Engr—Dec. 14, 1901. No. 44955.

Motor Vehicles with Overhead Trolley and without Track (Gleislos Motorbahnen mit Elektrischem Oberleitungs antrieb). Max Schiemann. An illustrated description of a motor omnibus system suitable for small villages as a preliminary to the establishment of tramways. 2000 w. Elektrotech Zeitschr—Nov. 21, 1901. No. 45192 B.

We supply copies of these articles. See page 811.

Steering.

The Demand for Improved Wheel Steering Devices. Hugh D. Meier. Describes various devices in use, discussing their defects. 900 w. Horseless Age—Dec. 18, 1901. No. 44968.

Tires.

Multiple Tires: A Query. Albert L. Clough. Describes a model of a "new and improved" wheel shown the writer, and discusses its possible advantages and disadvantages. 1000 w. Horseless Age—Dec. 11, 1901. No. 44945.

Trials.

The Principal Automobile Trials of the Year (Les Principals Epreuves Automobiles de l'Année). A review with tabulated data and results of the principal automobile trials in France in the year 1901. 3500 w. Génie Civil—Dec. 14, 1901. No. 45108 D.

Vibration.

The Vibration Automobiles (Les Trépidations dans les Voitures Automobiles). F. Drouin. Discussing the effects of inertia and the arrangement of cylinders, showing how the vibration may be reduced to a minimum. Two articles. 4000 w. Génie Civil—Dec. 7, 14, 1901. No. 45107 each D.

HYDRAULICS.

Flow.

A Proposed Solution of Some Hydraulic Problems. Charles H. Tutton. An attempt to solve determinately the question why the maximum velocity is found below the surface in channels. 6600 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44683 E.

Experiments at Detroit, Mich., on the Effect of Curvature upon the Flow of Water in Pipes. Continued discussion of paper in this subject by Gardner S. Williams, Clarence W. Hubbell, and George H. Fenkell. Ill. 15000 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44687 E.

Rational and Empirical Features of Flow of Water in Pipes. Letter from Mr. Clemens Herschel to Mr. I. P. Church, commenting on an article published Oct. 31, and Mr. Church's reply. 2300 w. Eng News—Dec. 19, 1901. No. 44985.

Plumbing.

Plumbing in the Park-Realty Building, New York. Illustrates and describes the work in an 80 x 100-ft. 12-story family hotel. 1300 w. Eng Rec—Dec. 7, 1901. No. 44823.

Pump.

The Schleifmühle High Speed Pump (Die Expresspumpe Schleifmühle). H. Ehrhardt. An account of the performance of this improved electrically driven deep mine pump. The valves are not mechanically operated. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1901. No. 45151 D.

Pumping Machinery.

Experiences in Reducing Water Ram Caused by Direct-Acting Pumping Engines. George E. Winslow. An account of an experience of the writer with water ram at the water works of Waltham, Mass. 3000 w. Jour N Eng Water Wks Assn—Dec., 1901. No. 44882 F.

Hydraulic Pumping Machinery. Fr. Frolich. Abstract of a paper read before the Society of German Engineers, at Witten. States the advantages of hydraulic pumping plants giving illustrated descriptions of plants built by Berliner Maschinenbau Actien-Gesellschaft. 2400 w. Engng—Dec. 6, 1901. Serial. 1st part. No. 44938 A.

See Electrical Engineering, Power Applications.

Scoop Wheel.

Test of a Scoop Wheel (Beproeving van een Scheprad). J. C. Dijxhoorn. Describing the Paul scoop wheel for raising large volumes of water against a low lift, with data and results of tests, showing an efficiency of 59 per cent. 2500 w. De Ingenieur—Nov. 16, 1901. No. 45205 D.

Velocity Measurements.

Current Meter and Weir Discharge Comparisons. Discussion of paper by Edward C. Murphy. 2600 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44684 E.

Water-Wheel.

A "Tangential" Impact Water Wheel. Illustrates and describes a new style of impulse wheel. 1200 w. Eng News—Dec. 12, 1901. No. 44891.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings (Kugellager), F. Heerwagen. An examination of the rolling conditions in various forms of ball bearings, with especial reference to the pressure and wear. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1901. No. 45154 D.

Bearings.

Radial Machine Bearings. J. Richards. An illustrated article discussing the influence of design upon their wearing qualities. 1500 w. Mach, N. Y.—Dec., 1901. No. 44776.

Brace Pins.

On the strength of Brace Pins. Considers the different modes of failure, and gives a solution of a problem submitted. 2000 w. Prac Engr—Dec. 13, 1901. No. 45024 A.

We supply copies of these articles. See page 811.

Brakes.

Theory and Design of Mechanical Brakes. E. R. Douglas. Mathematical demonstration. 1500 w. Am Mach—Dec. 19, 1901. Serial. 1st part. No. 44979.

Centrifugal Force.

Centrifugal Force Diagrams. P. Muller. Gives diagrams constructed to obtain the rim tension per square inch for a given metal in one reading at any radius or speed, without having to resort to laborious calculations. 400 w. Am Mach—Nov. 28, 1901. No. 44646.

Cranes.

See Electrical Engineering, Power Applications.

Crank Pins.

Care and Repair of Crank Pins. Suggestions for methods of keying, repairing, etc. 2500 w. Power—Dec., 1901. No. 44960.

Dies.

An Improved Dial Feed Armature Disk Die. Joseph V. Woodworth. Illustrated description of die and attachments which can be used on any simple-acting power press to which a connecting rod for operating the feed can be connected. 900 w. Am Mach—Dec. 19, 1901. No. 44980.

Blanking, Drawing and Half-Wiring. William Doran. Illustrates and describes a combination die. 1400 w. Am Mach—Dec. 19, 1901. No. 44978.

Drawings.

A Decimal System for Numbering Working Drawings. Henry L. Hutson. Describes a system similar to the Dewey Decimal System used for numbering books in libraries. Also editorial. 2000 w. Am Mach—Dec. 26, 1901. No. 45061.

Drilling.

A High Speed and Two Tapping Attachments for Drillers. Herman Isler. Illustrated description. 600 w. Am Mach—Nov. 28, 1901. No. 44647.

Deep Hole Drilling. A collection of useful data covering both large and small work, with illustrations. 4800 w. Mach, N. Y.—Dec., 1901. No. 44775.

Electric Driving.

See Electrical Engineering, Power Applications.

Elliptic Lathe.

Elliptic Lathe with Movable Tool (Tours Elliptiques à Outil Guidé). Ch. Dantin. With especial reference to the lathe of MM. Vrignault & Brosse for turning elliptical forms. 2000 w. Génie Civil—Nov. 30, 1901. No. 45104 D.

Equipment.

The Engineer in the Foundry: A New Departure. An illustrated article prepared from the lecture of Samuel Groves, at the Buffalo convention of the Am. Found. Assn. showing the methods pursued in providing foundry appliances and equipment for the works of the Westinghouse Machine Co. 2800 w. Foundry—Dec., 1901. No. 44655.

Lathes.

A Lathe Shown at the Pan-American. Illustrated account of the work of Tahar Ben Mh. of Tunis, and his tools. 600 w. Am Mach—Dec. 26, 1901. No. 45062.

Capstan Lathe. Illustrates and describes a new tool exhibited at the National Cycle Show, especially adapted for high-speed work. 900 w. Engng—Dec. 13, 1901. No. 45040 A.

Machine Tools.

Improved Planing and Shaping Machines (Neuere Hobel und Stossmaschinen). P. Janzon. Illustrating the heavy planer built by the Berlin Machine Tool Works. The bed is driven by a pair of longitudinal screws. Serial, Part I. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1901. No. 45148 D.

Machine Tools and Their Use in Locomotive Works. A supplement giving many illustrated descriptions of machines and explaining how they are used. 19300 w. Engr, Lond—Dec. 13, 1901. No. 45045 A.

Machine Tools at the Glasgow Exhibition. Fred. Bathurst. An illustrated article with special reference to the requirements of dynamos and motor manufacture. 2500 w. Elec Rev, Lond—Nov. 22, 1901. Serial. 1st part. No. 44724 A.

Machine Tools at the National Show. Illustrations of screw machine, and shaving lathe, with description of these and other exhibits. 2700 w. Engng—Dec. 6, 1901. No. 44928 A.

Machine Tools at the Stanley Show. Illustrates and describes tools of special interest. 4200 w. Engng—Nov. 29, 1901. No. 44851 A.

Speed of Machine Shop Tools. J. W. E. Littledale. Read before the Northern Coast Inst. of Engrs. & Shipbuilders. Suggestions tending to improve the results of out-of-date tools, as well as the proper working of new tools. 4000 w. Ir Trd Rev—Dec. 26, 1901. No. 45064.

Supplementary Report on Machine Tools at the Paris Exposition 1900 (Nochtrag zum Bericht über die Werkzeugmaschinen auf der Weltausstellung in Paris, 190 Hermann Fischer. Describing special forms of turret lathes and milling machines. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 7, 1901. No. 45161 D.

The Guest Universal and Cutter Grinder. Illustrated description of a tool designed to accurately and rapidly do the grinding required in manufacturing establishments.

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explaining its operation. 1800 w. Engng —Dec. 6, 1901. No. 44931 A.

Machinery.

Machining Drill Columns. William Doran. Illustrates tools and describes their use. 1000 w. Am Mach—Dec. 12, 1901. No. 44877.

Melting.

Melting Loss in the Cupola Process. Tabulated information reported to the American Foundrymen's Association. 1000 w. Jour Am Found Assn—Dec., 1901. No. 44755.

Molding.

Molding a Large Cross Pipe. Illustrated description of the method used. 1000 w. Am Mach—Dec. 5, 1901. No. 44771.

Pipe Making.

The Manufacture of Locking-Bar Pipes in Western Australia. Stafford Ransome. Illustrates and describes the making of the Ferguson locking-bar water pipe at Falkirk, Western Australia. 2400 w. Engr, Lond—Nov. 29, 1901. No. 44858 A.

Pistons.

Centering a Piston. H. H. Kelley. Explains why the piston should occupy a perfectly central position, the tools necessary, and the method of doing the work. Ill. 2100 w. Mod Mach—Dec., 1901. No. 44806.

Piston Valves.

Locomotive Piston Valve. Discussion of this subject introduced by Mr. John Player. 6800 w. Cent Ry Club—Nov., 1901. No. 44804 C.

Polishing.

A Polishing Arrangement for Gold and Silver, and the Collecting of the Dust. Describes a system used in polishing jewelry. 600 w. Am Mach—Dec. 26, 1901. No. 45063.

Rack Shaper.

The Fellows Rack Shaper. Illustrated description. 700 w. Am Mach—Nov. 28, 1901. No. 44644.

Roller Bearings.

Further Comparisons of Roller Bearings. Thomas W. How. Presents the requirements of satisfactory roller bearings and results obtained. 3800 w. Tram & Ry Wld—Nov. 14 1901. No. 44753 B.

Shop Economics.

See Industrial Economics.

Shops.

The Ventilation, Lighting and Cleanliness of Small Workshops. John Robertson. Discusses the proper sanitation of such shops. 3000 w. Plumb & Dec—Dec. 2, 1901. No. 44889 A.

Spiral Gearing.

Spiral Gears Set at 90 Degrees. John Randol. Discusses the advantages of spiral gears, and gives a very simple diagram by aid of which they can be cut with ordinary cutter. Ill. 2800 w. Am Mach —Dec. 5, 1901. No. 44773.

Steel Works.

The Barrow-Hematite Steel Works. Arthur J. While. Read at Barrow meeting of the Inst. of Mech. Engrs. Illustrated detailed description of the works and their equipment. 2300 w. Engng—Nov. 22, 1901. No. 44740 A.

Tools.

Some Special Turret Head Tools. Joseph V. Woodworth. Illustrates and describes tools for making small tubes used for perforating leather shoe tips. Also a tool for pointing slender needle valves on an incandescent oil lamp. 600 w. Am Mach—Dec. 5, 1901. No. 44772.

MATERIALS OF CONSTRUCTION.

Nickel-Steel.

Nickel Steel (L'Acier au Nickel). Discussing the toughness and ductility imparted to steel by various proportions of nickel. 2000 w. Revue Technique—Nov. 25, 1901. No. 45114 D.

Testing.

The Congress of the Association for Testing Materials at Budapest, September, 1901 (Le Congrès des Méthodes d'Essai Tenu à Budapest au Mois de Septembre, 1901). A. Pourcel. A general abstract of the proceedings of the section for testing metals. 2500 w. Génie Civil—Nov. 23, 1901. No. 45101 D.

Wire.

The Permanent Deformations of Metallic Wires (Déformations Permanentes des Fils Métalliques). Giving the results of tests by M. Lenoble, of Lille, showing the behaviour of wire under varying loads. 1200 w. Revue Technique—Nov. 10, 1901. No. 45109 D.

POWER AND TRANSMISSION.

Belt Transmission.

Horse Power Transmitted by Belts and Gears, and Diagrams for Obtaining Belt Dimensions. Robert A. Bruce. Gives a diagram for showing graphically the relations which exist between the horse power, the linear speed, and the effective tension or pressure on teeth, in the case of belt or gear transmissions, with directions for the use of the diagram. 1300 w. Prac Engr—Nov. 29, 1901. Serial, 1st part. No. 44847 A.

The Efficiency of High Speed Belts (Die Arbeitsleistung Schnellaufender Riemen). Dr. H. Abbes. An examination of the in-

fluence of speed on belt efficiency with a view of determining the best belt speed. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1901. No. 45149 D.

Clutches.

Clutches (Les Embrayages). M. Enverte. The first installment of an elaborate detailed treatise on clutches and couplings of all sorts. The present portion treats of classification. 5000 w. Revue de Mécanique—Nov. 30, 1901. No. 45141 E + F.

Coal Handling.

Coal-Conveying Plant at Edinburgh (McDonald Road) Electricity Works. Brief illustrated description. 1200 w. Elect'n, Lond—Dec. 13, 1901. No. 45026 A.

Modern Coal Handling Machinery. Waldon Fawcett. Reviews the great development in this field during the last ten years. Ill. 2000 w. Am Mfr—Aug. 22, 1901. No. 44698.

Gearing.

Concerning Toothed Gearing (Ueber Zahnräder). Alois Schaffer. A mathematical examination of the action of cycloidal and involute gear teeth. Two articles. 9000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 22, 29, 1901. No. 45169 each B.

Hydro-Electric Plants.

See Electrical Engineering, Power Applications.

Pneumatic Distribution.

A Pneumatic Tube System of Parcel Distribution in Boston. Edward D. Sabine. Illustrated description of this recently constructed line and its operation. 1200 w. Eng News—Dec. 5, 1901. No. 44794.

Power Cost.

The Cost of Power for Small Plants. W. H. Wakeman. Discusses the conditions that affect cost and gives data that will enable those interested to make comparisons of fuel costs. 2000 w. Mod Mach—Dec., 1901. No. 44807.

Power Plant.

Description of the Steam Engineering Plant at the Navy Yard, New York. C. H. Matthews. An illustrated description of the new buildings and their equipment. 2700 w. Jour Am Soc of Nav Engrs—Nov., 1901. No. 44639 H.

New Power Plant of the National Cash Register Company. Illustrated description of the new steam plant recently built. 1200 w. Eng Rec—Nov. 30, 1901. No. 44661.

Power Plant of a New Sulphite Mill. Illustrated description of a recent installation of steam power equipment in a sulphite mill at Lockport, N. Y. 3000 w. Engr, U. S. A.—Dec. 1, 1901. No. 44759.

Variable Speed.

Bicycle Differential Gears. From *La Nature*. Illustrated description of various systems. 1800 w. Sci Am Sup—Dec. 21, 1901. No. 44973.

SPECIAL MOTORS.

Alcohol Motors.

Exposition of Motors and Apparatus for Utilizing Methylated Alcohol (Concours et Exposition de Moteurs et Appareils Utilisant l'Alcool Dénaturé). G. Coupan. Describing the exhibits and giving fully tabulated data and results of tests of motors. 2500 w. Génie Civil—Nov. 30, 1901. No. 45102 D.

The Exposition of Apparatus for Utilizing Methylated Alcohol (L'Exposition des Appareils Utilisant l'Alcool Dénaturé). H. Pouleur. A review of the motors and the warming and lighting apparatus exhibited at Paris, Nov., 1901. 3500 w. Rev Univ des Mines—Nov., 1901. No. 45128 H.

Gas Engines.

A Note on the Computations for Gas Engines (Beitsag zur Berechnung der Gasmaschine). R. Barkow. A mathematical investigation of the forces acting in a gas engine as deduced from the indicator diagram. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1901. No. 45150 D.

Design for a I. H. P. Gas Engine. J. C. Brocksmith. Description and working drawings of a gas engine to develop continuously one brake horse-power at the moderate speed of 500 r. p. m. Especially designed for electrical work. 3700 w. Am Elect'n—Dec., 1901. No. 44789.

Point of Ignition and I. H. P. in Gas Engines. Charles E. Lucke. An account of tests made to find some of the relations between the varying point of ignition and the resulting work area or indicated horse-power. 2000 w. Horseless Age—Dec. 4, 1901. No. 44765.

Gasoline Motors.

See Mechanical Engineering, Automobiles.

Heat-Engine.

The Heat-Engine Problem. Charles E. Lucke. Gives a review of the cycles in which heat engines may work, and decides that only the Brayton and the Otto are available in practice. Gives the requirements of a proper apparatus and the results of a series of experiments to devise such an one. Ill. 1500 w. Trans Am Soc of Mech Engrs, No. 926—Dec., 1901. No. 44846 C.

STEAM ENGINEERING.

Boilers.

Boiler Tests. J. Rowland Brown. Considers the different kinds of boiler tests—

for capacity, for efficiency, defects, fuel economy, design, operation, etc., and the importance of knowing the conditions under which the test was made. 4200 w. Engr, U. S. A.—Dec. 1, 1901. No. 44760.

On the Use of Zinc in Boilers. R. A. Douglass. Considers cases where zinc is useful and precautions to be taken when using it. 1000 w. Am Elect'n—Dec., 1901. No. 44786.

See Mechanical Engineering, Automobiles.

Chimneys.

A 108-Foot Concrete Steel Chimney. Illustrates and describes a chimney built in Jersey City, according to the Ransome system, which employs cold-twisted square steel bars to reinforce the concrete. 1400 w. Eng Rec—Nov. 30, 1901. No. 44663.

Brick Chimneys for Power Stations. William D. Ennis. Discussion of the design and construction. Ill. 2500 w. Am Elect'n—Dec., 1901. No. 44785.

Some Interesting Features of Recent Chimney Construction. Illustrates and describes three large chimneys of steel, each of which has interesting features, and also a concrete steel chimney. 3500 w. Eng News—Dec. 19, 1901. No. 44981.

The New Stack of the Prudential Building, Newark, N. J. Illustrated description of a chimney 231-ft. high, built independent of but closely adjacent to a tall office building. 900 w. Eng Rec—Dec. 14, 1901. No. 44938.

Comparative Practice.

English, American, and Continental Steam Engineering. Philip Dawson. Mr. Dawson's third paper discusses Continental practice, giving illustrations of numerous important power plants in various parts of Europe. 4500 w. Engineering Magazine—Jan., 1902. No. 45050 B.

Compound Engine.

500 Horse-Power Compound Engine and Electric Generator. An example of a British-built engine, on the lines as laid down by American practice, for the generating of electric energy for tramway purposes. Illustrated description. 900 w. Engng—Nov. 22, 1901. No. 44738 A.

New Standard Three-Cylinder Compound Engine. Illustrated description of an engine designed for high speeds, uniform turning moment, and efficiency under varying conditions of load. 1400 w. Elec Rev, Lond—Nov. 22, 1901. No. 44725 A.

Condenser.

Evaporative Condenser of 4500 Horse Power (Aérocondenseur de 4500 Chevaux). F. Fouché. Illustrated description of a large evaporative surface condenser erected at Kalgoorlie, Western Australia. 4000 w. Mem Soc Ing Civ de France—Oct., 1901. No. 45121 G.

Dry Steam.

Talk on Dry Steam and Steam Separators. James Bonar. Recommends the use of separators, discussing their utility, and points in their selection and location. 1400 w. Am Mfr—Dec. 12, 1901. No. 44946.

Engines.

See Mechanical Engineering, Automobiles.

Explosion.

Boiler Explosion at the Penberthy Injector Co., Detroit, Mich. Illustrated account of the disaster. 900 w. Eng News—Dec. 19, 1901. No. 44986.

Feed Water.

The Purification of Boiler Feed Water. Abstract from the memorandum of C. E. Stromeyer, presented at the annual general meeting of the Manchester Steam Users' Assn. Discussion of water softeners is commenced in the present article. 2700 w. Prac Engr—Nov. 22, 1901. Serial. 1st part. No. 44714 A.

The Solubility of Sulphate of Lime. (Etude sur la Solubilité du Sulfate de Chaux). M. Boyer-Guillon. A review of the careful experiments of the author, showing the relations between temperature of feed water and the presence of dissolved sulphate of lime. 3500 w. Revue de Mécanique—Nov. 30, 1901. No. 45140 E+F.

Water Softening and Purifying. P. A. G. Bell. Read before the West of Scotland Iron & Steel Inst. Describes the Bell system of water purification. Explaining the principles involved and the method of working. 5200 w. Ir & Coal Trds Rev—Nov. 29, 1901. No. 44855 A.

Heating.

Indirect Steam Heating in a Residence. Illustrates and describes a system recently installed in the house of Charles Scribner, New York. 1400 w. Eng Rec—Dec. 14, 1901. No. 44941.

Heating and Ventilating.

Ventilation of an Office Building in Hartford. Illustrated description of one of the few plants for positively ventilating large office buildings. Direct-indirect radiation and a plenum system of ventilation are employed. 400 w. Eng Rec—Dec. 21, 1901. No. 45001.

Indicator Diagrams.

The Accuracy of Indicator Diagrams (Zur Genauigkeit der Indikatordiagramme). L. C. Wolff. Discussing the sources of error in indicator diagrams, and the methods of calibration and correction. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 14, 1901. No. 45164 D.

Jacketing.

Jacketing of Steam Cylinders. Editorial reviewing investigations in this field and

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giving suggestions for preventing loss of heat from cylinder condensation. 1500 w. Loc Engng—Dec., 1901. No. 44694 C.

Lubrication.

The Oil Supply in Crank Cases of Inclosed Engines. Hugh D. Meier. Considers ways of accomplishing the desired results. 700 w. Horseless Age—Dec. 18, 1901. No. 44970.

Mechanical Plant.

Mechanical Installation in the Modern Office Building. Reginald Pelham Bolton. Discussion of paper by Charles G. Darrach. 6800 w. Pro Am Soc of Civ Engrs—Nov., 1901. No. 44685 E.

Power, Ventilation and Heating in the Colonial Building, Boston. A ten-story structure in which the four lower stories and basement are used as a theatre, and the remaining stories as an office building. Many interesting features are described. Ill. 3500 w. Eng Rec—Nov. 30, 1901. No. 44665.

Pipe Covering.

Test of Pipe Covering. George H. Barrus. Made before mach. engrs. and others at the Manhattan Ry Power House, N. Y., on Nov. 12, 1901. An account of tests made, giving results. 2800 w. Am Mfr—Dec. 5, 1901. No. 44805.

Powdered Coal.

Two Recent Systems for Burning Powdered Coal. Illustrates and describes the cyclone pulverizer system and the aeropulverizer system. 1500 w. Eng News—Nov. 28, 1901. No. 44660.

Shaft-Governor.

Evolution of the Shaft Governor. Prof. R. C. Carpenter. Paper at meeting of the Engine Builders' Assn. Discusses the various forms of shaft governor and their method of action. General discussion. 9300 w. Engr, U. S. A.—Dec. 16, 1901. No. 44957.

Steam Pipes.

Transverse Stresses in Steam Pipes. A. S. Mann. Discusses the relative length of various mains and branches. 1800 w. Am Elect'n—Dec., 1901. No. 44788.

Steam Power.

Steam Power Generation. G. Croydon Marks. A review of the earliest attempts at the generation of steam power. Ill. 1600 w. Prac Engr—Nov. 22, 1901. Serial. 1st part. No. 44713 A.

Stoking.

A Large Boiler Stoking Plant. A large plant in Glasgow is illustrated and described in detail. It supplies sixteen boilers and is capable of dealing with thirty tons of coal per hour. 1800 w. Engr, Lond—Dec. 6, 1901. No. 44925 A.

Thermal Conductivity.

The Transfer of Heat from Steam to Water Through a Partition. H. L. Hepburn. A report of experimental investigations. 3300 w. Power—Dec., 1901. No. 44959.

Turbines.

Tests of the De Laval Turbine (Versuche an einer de Laval Dampfturbine). E. Lewicki. Especially comparing the results with saturated and with superheated steam, showing the advantage of the latter. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 20, 1901. No. 45157 D.

The Future of the Steam Turbine. W. E. Warrilow. A review of the advantages of the turbine over the reciprocating engine, with special reference to electric generating stations. 1200 w. Elec Rev, Lond—Nov. 15, 1901. No. 44811 A.

The Steam Consumption of the De Laval Steam Turbine (Dampfverbrauchsversuche mit de Lavalschen Dampfturbinen). A. Schmidt. Giving data and results of a careful test, showing a total steam consumption of 15.37 pounds per brake horse power, including the air pump resistance. 1800 w. Zeitschr d Ver Deutscher Ing—Nov. 23, 1901. No. 45152 D.

Valves.

Piston, Corliss, and Double-Beat Valves. Translation of a lecture by M. Vanderstegen, delivered at Ghent. States why the Corliss and double-beat valves have been abandoned in favor of piston valves. 2800 w. Engr, Lond—Dec. 6, 1901. No. 44927 A.

Valve Gears.

Improved Valve Gears for Steam Engines (Neuere Steuerungen für Dampfmaschinen). H. Dubbel. Illustrating recent automatic valve gears for Corliss and poppett-valve engines. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1901. No. 45156 D.

MISCELLANY.

Aeronautics.

Graphical Method of Studying the Path of a Dirigible Balloon (Méthode Graphique Permettant d'Etudier la Marche d'un Aerostat Dirigible). J. Armengaud. With diagrams showing the method of determining the path by the projection on the surface of the earth. 1200 w. Comptes Rendus—Nov. 25, 1901. No. 45132 D.

The Determination of the Speed of Dirigible Balloons (Méthode Permettant de Determiner la Vitesse Propre des Aerostats Dirigibles). H. Deslandres. Developing a mathematical formula and applying it to the experiments of Santos-Dumont. 1200 w. Comptes Rendus—Dec. 9, 1901. No. 45137 D.

The Engineer and the Problem of Aërial

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Navigation. George W. Melville. Considers that there is no basis for hoping the balloon or flying-machine will ever prove a commercial success. 4800 w. N Am Rev—Dec., 1901. No. 44706 D.

The Path of the Balloon of Santos-Dumont on October 19 (La Trajectoire sur le Sol de l'Aerostat Dirigible de M. Santos-Dumont dans l'Epreuve der 19 Octobre). J. Armengaud. An examination of the successful attempt for the Deutsch prize, with map of the route. 1200 w. Comptes Rendus—Dec. 9, 1901. No. 45,138 D.

Agricultural Machinery.

Agricultural Machinery and Tools (Die Landwirtschaftlichen Maschinen und Geräthe). H. Grundke. An illustrated review of the agricultural machinery and appliances exhibited at the Paris exposition, 1900. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1901. No. 45155 D.

Beams.

Experiments on the Flexure of Beams—Discovery of New Laws. Albert E. Guy. Describes experiments undertaken by the writer in which he discovered some laws which had escaped investigation. 2500 w. Am Mach—Dec. 12, 1901. Serial. 1st part. No. 44876.

Coining Machinery.

Minting Machinery and Appliances. Edwin S. Church. An outline of the mechanical operations involved in the coinage of money, with a brief description of the various electrical installations. Ill. 4000 w. Jour Fr Inst—Dec., 1901. No. 44,843 D.

Combustion.

Shimer's Combustion Apparatus. Report of the Franklin Institute on the improved crucible device of P. W. Shimer, to whom was awarded the John Scott Legacy medal and premium. 900 w. Jour Fr Inst—Dec., 1901. No. 44845 D.

Decoration.

The Decorating of Sheet Steel Painted Ware by Machine Methods. Horace E. Whitney. Describes a method where the labor is decreased and the quality and character of the design raised to a higher standard. 3800 w. Ir Age—Dec. 26, 1901. No. 45003.

Fire Prevention.

The Berlin Exposition for Fire Protection Appliances, 1901 (Die Internationale Austellung für Feuerschutz und Feuerrettungswesen in Berlin, 1901). Kaemmerer & Meyer. Illustrating and describing numerous forms of fire engines and other appliances. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 7, 1901. No. 45,159 D.

Fulton.

Robert Fulton. Address of Admiral George W. Melville at the unveiling of the memorial erected by the American Society of Mechanical Engineers. 3800 w. Ir Age—Dec. 12, 1901. No. 44871.

Graphics.

The Theory and Application of Graphical Computations (La Theorie et Applications de la Nomographie). Rodolphe Soreau. A discussion of the methods of constructing diagrams for the rapid computation of engineering data, with numerous examples. 1200 w. Mem Soc Ing Civ de France—August, 1901. No. 45117 G.

Low Temperatures.

The Production and Maintenance of Low Temperatures (Production et Maintien des Basses Températures). M. d'Arsonval. A discussion of the uses of solidified carbonic acid, of acetylene snow, and of liquid air. 1200 w. Comptes Rendus—Dec. 9, 1901. No. 45136 D.

Mechanics.

The Conservation of Energy from the Standpoint of the Engineer (Die Erhaltung der Energie vom Standpunkt des Ingenieurs). An examination of the manner in which mechanical energy is transformed in the course of various engineering operations. 2500 w. Zeitschr d Ver Deutscher Ing—Dec. 7, 1901. No. 45162 D.

Metric System.

Historical Sketch of the Foundation of the Metric System. M. Bassot. Translated from the Annuaire pour l'an 1901 publie par le Bureau des Longitudes, Paris. 9800 w. Sch of Mines Qr—Nov., 1901. No. 44964 D.

Pistol.

A New Automatic Pistol. Illustrated description of the Mars pistol and its operation. 1200 w. Engr, Lond—Dec. 6, 1901. No. 44924 A.

MINING AND METALLURGY

COAL AND COKE.

Brown Coal.

Brown Coal at Narracau (V.). Henry C. Jenkins. A report by the government metallurgist on this deposit. 1900 w. Aust Min Stand—Oct. 17, 1901. No. 44,729 B.

British Coalfields.

British Coalfields; Their Extent, Duration and Condition of Working. The

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first of a series of twenty or more articles on the most prominent features and the most recent phases of this industry. 2000 w. Ir & Coal Trds Rev—Dec. 6, 1901. Serial. 1st part. No. 44917 A.

Coal Cutting.

The Use of Coal Cutting Machinery in the United States (Ueber die Verwendung von Schrämmaschinen bein Kohlbergbau der Vereinigten Staaten). H. Mellin. Describing the machines in general use and the extent to which they are used in America. 7500 w., 4 plates, Glückauf—Dec. 7, 1901. No. 45184 B.

Crushing Strength.

The Crushing Strength of Coal. Prof. R. C. Carpenter. Investigations of importance in connection with mining operations, where columns of coal are often left to support the roof of the mine. 1200 w. Sib Jour of Engng—Dec., 1901. No. 44,994 C.

Great Britain.

Britain's Cheap Coal Supplies. The present article discusses the report of the Argyll Commission, and the light that has been thrown on this subject since that report was issued some thirty years ago. 3400 w. Ir & Coal Trds Rev—Nov. 22, 1901. Serial. 1st part. No. 44734 A.

Holland.

The Coal Basin of Limburg, Holland (Le Bassin Honillier du Limbourg Hollandais). A. Habets. A general description of these important bituminous coal measures, with maps and table of borings. 4500 w. 2 plates. Rev Univ des Mines—Nov., 1901. No. 45125 H.

Illinois.

The Divernon Coal Mine. J. J. Rutledge. An illustrated description of the plant and arrangements at mine No. 6, of the Madison Coal Co., at Divernon, Illinois. 4500 w. Mines & Min—Dec., 1901. No. 44,779 C.

India.

Indian Coal. Concerning the recent progress made in the coal mining industry, the extent of the coal fields, etc. 1300 w. Engr, Lond—Nov. 29, 1901. 44860 A.

The Coal Question in India. Discusses the production, companies, labor question, mining methods, etc. 4800 w. Ind & East Engr—Nov., 1901. Serial. 1st part. No. 45034 B.

Japan.

The Coal Mines and Coal Trade of Japan. Gives a series of sectional maps showing the location of the principal collieries, giving a report of the mines, especially the Müke mines. 1200 w. Ir & Coal Trds Rev—Dec. 6, 1901. No. 44916 A.

Kansas.

Kansas Coal Mining. W. R. Crane. An illustrated article describing the deposits, methods of prospecting and mining, and other details. 5800 w. Eng & Min Jour—Dec. 7, 1901. No. 44828.

COPPER.

Cuba.

The Copper Mines of Santa Clara Province, Cuba. T. Weyland Vaughan. Describes the mines and the general geology, giving also an outline of the topographical features. Ill. 3700. Eng & Min Jour—Dec. 21, 1901. No. 45016.

Estimation.

Volumetric Estimation of Copper. Describes a method by which copper may be determined in its ores and metallurgic products in the shortest time and with the greatest accuracy possible. 1300 w. Aust Min Stand—Oct. 31, 1901. No. 44731 B.

Metallurgy.

The David Copper Process. Illustrates and describes a special converter called a "selector," explaining the principle and manner of operating and stating the advantages of the process. 3000 w. Engng—Nov. 22, 1901. No. 44739 A.

GOLD AND SILVER.

Assay Returns.

A Standard Assay Certificate Form. Submits a form suggested for assay returns, discussing the deficiencies of the forms usually employed. 1800 w. Min & Sci Pr—Dec. 14, 1901. No. 44971.

Austria-Hungary.

Gold Mining in the XIX Century, with Especial Reference to Austria-Hungary (Das Gold in XIX Jahrhundert mit besonderer Berücksichtigung der Oesterr.-Ungar. Monarchie). L. St. Rainier. With tables and diagrams showing the production of the various countries. 3500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 15, 1901. No. 45165 B.

British Columbia.

Mining Operations in Atlin, B. C. R. Lind Watson. An illustrated description of some of the places and the hydraulic plants which are being installed. 2200 w. Mines & Min—Dec., 1901. Serial. 1st part. No. 44777 C.

The Dry Ores of the Slocan, B. C. R. C. Campbell-Johnston. Describes this area and the experiences of those mining its ores, the attempts to treat the ore on a paying basis, and gives suggestions for other treatments that may be applicable. 1800 w. Can Min Rev—Nov. 30, 1901. No. 44697 B.

Cyanide Mill.

A Cyanide Mill of the Black Hills, South

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Dakota. Everett B. Sawyer. Describes the work done and gives the cost of milling. 1100 w. Min & Sci Pr—Dec. 7, 1901. No. 44873.

Cyanide Plant.

A Wet-Crushing Cyanide Plant at Ely, Nevada. Illustrated description of a mill nearing completion. It is one of the largest combination plants in the country for the treating of low grade gold ore by cyaniding after wet crushing and amalgamation. 2500 w. Eng & Min Jour—Dec. 7, 1901. No. 44829.

Goldfield.

Pitfield Plains Goldfield (V.). Stanley Hunter. A report of this field, describing the deposits, and the mines of the various companies working in this district. 2500 w. Aust Min Stand—Oct. 24, 1901. Serial. 1st part. No. 44730 B.

Idaho.

Some Idaho Mining Districts. Arthur Lakes. Illustrated description of the geological characteristics of the State, and of the mines of the Hailey gold belt and the De La Mar district. 5000 w. Mines & Min—Dec., 1901. No. 44780 C.

Making Gold.

Can Gold Be Made Artificially? Edward Booth. Discusses the claims made by the late Professor Wynne of Denver Col., that he had discovered the secret of making gold. 1400 w. Min & Sci Pr—Dec. 7, 1901. No. 44872.

Nevada.

The Mines of Tonapah Lake, Nevada. Describes a district recently discovered situated in a country very hard to prospect on account of lack of water. The ratio of gold and silver is about 39 per cent. gold and the rest silver. 1200 w. Eng & Min Jour—Dec. 14, 1901. No. 44951.

New Field.

A New Gold Field. W. K. Draper, in the *N. Y. Times*. An account of the deposits in the Wichita Mountains. Gold, copper and oil are found, but whether in paying quantities is not yet determined. 2000 w. Sci Am Sup—Nov. 30, 1901. No. 44654.

Sulphide Ores.

Broken Hill Sulphide Ores. J. C. Moulden. Describes the ores, their preparation for treatment, methods of treatment, web concentration of argentiferous sulphides, etc. 3500 w. Aust Min Stand—Oct. 31, 1901. Serial. 1st part. No. 44733 B.

Transvaal.

Mining Conditions in the Transvaal. A report of the present conditions. The industry slowly reviving under many difficulties. 2500 w. Eng & Min Jour—Dec. 21, 1901. No. 45017.

IRON AND STEEL.

Blast Furnaces.

Difficulties in Blast Furnace Operation (Ueber Störungen in Hochofengang). B. Osann. A study of the reactions occurring in blast furnace operation, with reference to the irregularities occurring in practical experience. 4000 w. Stahl u Eisen—Dec. 1, 1901. No. 45185 D.

Modern Iron Blast-Furnace Practice. F. H. Crockard. With special reference to the Methods and appliances which have developed as the result of the demand for intensified production. 3000 w. Engineering Magazine. Jan., 1902. No. 45052 B.

Feed Cone.

Electrically Operated Furnace Feed Cones (Elektrisch Betriebene Gichtglockenaufzüge). F. Janssen. Illustrating and describing applications of electric motors to the operation of the cone valves used on blast furnaces to admit the charge and retain the gases. 3000 w. Stahl u Eisen—Dec. 15, 1901. No. 45188 D.

Ferrosilicon.

The State of Silicon in Cast Iron and in Low Ferrosilicon (Sur l'Etat du Silicium dans les Fontes et les Ferro-silicums à Faible Teneur). P. Lebeau. A review of chemical researches showing the true combination existing between the silicon and the iron; confirming the results of metallographical investigations. 1200 w. Comptes Rendus—Dec. 9, 1901. No. 45,139 D.

Fuel.

The Fuel Consumption in Iron Making (Ueber die Bremstoffverluste im Eisenhüttenbetrieb). A. Bergström. A discussion of possible sources of fuel economy in iron works, especially in connection with gaseous fuel. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 30, 1901. No. 45182 B.

Lake Superior.

The Hon. Peter White. A biographical sketch, including a history of the development of the Lake Superior iron region. 9200 w. Marine Rev—Dec. 12, 1901. Serial. 1st part. No. 44894.

Manganese.

On the Determination of Manganese in Spiegel. Thomas F. Hildreth. A comparison of new and modified methods for the estimation of manganese. 2000 w. Sch of Mines Qr—Nov., 1901. No. 44966 D.

The Manganese Deposits of Gandarella, Minas Geraes, Brazil. Joaquin G. Michaeli. Describes the deposits and their location. 1100 w. Eng & Min Jour—Dec. 21, 1901. No. 45018.

Mexico.

Mexican Iron and Coal. Information concerning the location and value of these

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deposits. Map. 1700 w. Col Guard—Dec. 6, 1901. No. 44919 A.

Open Hearth.

The Early History of Open Hearth Steel Manufacture in the United States. Samuel T. Wellman. Presidential address before the American Society of Mechanical Engineers. 6500 w. Ir Age—Dec. 5, 1901. No. 44754.

Ore Process.

A Variation in the Ore Process (Une Variation du Procéé au Minerai). E. de Loisy. A description of the Goriainof open hearth steel process, used in the Ural district, Russia. 6000 w. Bull Soc d'Encour—Nov., 1901. No. 45130 G.

Ore Valuing.

The Valuation of Iron Ores (Ueber die Berwerthung von Eisenerzen). P. Lisl. Deriving a formula from which the value of an ore can be determined. The data are the price of pig iron, and the composition of the ore. 1200 w. Stahl u Eisen—Dec. 15, 1901. No. 45178 D.

Pig Iron.

On a Calometric Method for the Estimation of Sulphur in Pig Iron. W. G. Lindsay. Describes method and compares the results with the regular method. 800 w. Sch of Mines Qr—Nov., 1901. No. 44,965 D.

Rail Rolling.

Rail Rolling at Lower Temperatures During 1901. S. S. Martin. Information relating to rolling temperatures and the value of microscopic study. Ill. 1500 w. Ir Age—Dec. 26, 1901. No. 45002.

Rolling Mills.

The Neepsend Rolling Mills, Sheffield. Describes the improvements made and work done in this English mill. The products are wire, block sheets, sheets for saw blades, blanks for files, tool steel bars, etc. 2300 w. Engr, Lond—Nov. 29, 1901. No. 44857 A.

Steel Making.

Basic or Bertrand-Thiel Process (Thomas oder Bertrand-Thiel Process). O. Thiel. A comparison between the two processes, with tabulated analyses of products, showing that the open-hearth process is to be that of the future. 3000 w. Stahl u Eisen—Dec. 1, 1901. No. 45186 D.

Steel Works.

See Mechanical Engineering, Machine Works and Foundries.

MINING.

Accidents.

Berryburg Mine Disaster, W. Va. James W. Paul. A description of the mine, the conditions under which it was operated and the probable cause of the explosion. 3000 w. Mines & Min—Dec., 1901. No. 44778 C.

Mining Accidents in the Years 1896-1900 (Die Betriebsunfälle bein Bergbau in den Jahren, 1896-1900). J. Sauer. A tabulated account of the mining disasters in the Vienna district, including upper and lower Austria, Salzburg, Moravia, Silesia, and Bukowing. Serial. Part I. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 16, 1901. No. 45180 B.

Brazil.

Mineral Resources of the State of Minas Geraes, Brazil. Senator Costa Senna. An illustrated account of deposits of gold, diamonds, iron, manganese and other valuable minerals. 1400 w. Min & Met—Dec. 15, 1901. No. 44976.

Caving.

The Caving of Shaft No. 7 of the Bascoup Colliery (L'Eboulement du Puits No. 7, de la Société Charbonnière de Bascoup). A. Robert. Describing the manner in which the caving was checked and the shaft repaired. 3500 w. 1 plate. Rev Univ des Mines—Nov., 1901. No. 45127 H.

Explosions.

The Nature of Explosions. Review of the lecture of Prof. Dixon, at the Midland Institute, Birmingham, Eng. Gives the history of their use and the advances made, describing various explosions and their action. 3700 w. Col Guard—Dec. 13, 1901. No. 45043 A.

Idaho.

Idaho's Mining Industry. Arthur Stanley Riggs. Historical review and review of the mineral resources of this State. Gives a table showing 25 minerals mined in paying quantities and 23 minerals found but not mined. 3000 w. Min & Met—Dec. 15, 1901. No. 44977.

Mexico.

The Mining District of Pachuca, Mexico. Ezequiel Ordonez. Historical and descriptive account of this silver mining district. 3500 w. Eng & Min Jour—Nov. 30, 1901. No. 44763.

Mine Power.

See Electrical Engineering, Power Applications.

Mining Industry.

The Value of Science and Training in the Mining Industry. E. J. Babcock. Read before the International Min. Cong. at Boise, Idaho. On the importance of government recognition of the mining and metallurgic industries. 3000 w. Mines & Min—Dec., 1901. No. 44782 C.

Mining Law.

The Russian Law of Gold Mining. C. W. Purington and J. B. Landfield, Jr. A digest of the Russian law, explaining and

commenting upon the text. 2500 w. Engineering. Magazine. Jan., 1902. No. 45048 B.

Quarry Methods.

Modern Quarry Methods. Extracts from a circular issued by the Ingersoll-Sergeant Drill Co., describing machine work. Ill. 1200 w. Stone—Oct., 1901. No. 44808 C.

Rescue Station.

The Colliery Rescue Station at Altofts. Illustrates and describes the arrangements for training men in the use of rescue appliances, and for testing their reliability. 2200 w. Col Guard—Nov. 29, 1901. No. 44856 A.

Shafts.

Clearing a Shaft of Water During Sinking. V. Kadainka, in *Oesterreichische Zeitschrift für Berg und Hüttenwesen.* Illustrated description of the method used. 1500 w. Col Guard—Dec. 6, 1901. No. 44918 A.

Tamping.

The Value of Tamping. A. W. Warwick. The writer favors the use of tamping and gives arguments supporting his conclusions. 1200 w. Min Rept—Dec. 5, 1901. No. 44841.

MISCELLANY.

Alaska.

A Trip to Dawson. Auguste Mathez. Describes the tour as easy and pleasant in the summer, all the difficulties and dangers of the past having disappeared. 2500 w. Mines & Min—Dec., 1901. No. 44,781 C.

Alloys.

Alloys as Solutions. John Alexander Matthews. Historical review of metallurgy and the recent advances in alloys research, noting the general properties of metals, pointing out the similarities between ordinary solutions and alloys. 7200 w. Eng & Min Jour—Dec. 21, 1901. Serial. 1st part. No. 45019.

Aluminium.

Aluminium. Ernest Wilson. On the increase in the output, the progress in manufacture; showing how rapidly the electrolytic process has developed, alloys, as a conductor of electricity, uses, etc. Also discussion. 9000 w. Jour Soc of Arts—Dec. 13, 1901. No. 45023 A.

Asbestos.

Asbestos—Where It Is Found. Joseph Hyde Pratt. Describes the two distinct minerals called asbestos, and their varieties, the location of deposits, especially the deposit in Vermont. 2700 w. Am Mfr—Dec. 12, 1901. No. 44947.

British India.

Mineral Wealth of British India. A Summary of a statement issued by the director general of statistics. 1000 w. U. S. Con Rpts, No. 1210—Dec. 10, 1901. No. 44792 D.

Chili.

The Mining and Metallurgical Situation in Chili (Situation Minière et Métallurgique du Chili). Ch. Vattier. A review of the gold, silver, copper and other mining industries of Chili, Peru, Brazil, and other countries of South America. 8000 w. Mem Soc Ing Civ de France—Sept., 1901. No. 45118 G.

Corundum.

Montana Corundum. Leverett S. Ropes. Brief description of the deposits. 900 w. Eng & Min Jour—Dec. 14, 1901. No. 44,950.

Germany.

Germany's Mining and Metallurgical Industries. H. L. Geissel. An illustrated review of these industries and their development. 2800 w. Min & Met—Dec., 1901. No. 44840.

Glass.

Machinery for Working Glass (Appareils Servant an Travail Mécanique des Glaces). E. Zoude. A mathematical discussion of the theory of machines for polishing and working glass. 10,000 w. 1 plate. Rev Univ des Mines—Nov., 1901. No. 45124 H.

Nickel.

The Sudbury Nickel Mines. A. McCharles. Some points in relation to prospecting with a favorable report of progress in nickel mining. 700 w. Eng & Min Jour—Dec. 7, 1901. No. 44830.

Petroleum.

Oil of the Northern Rocky Mountains. Bailey Willis. Considers the known occurrences in Canada and the United States, the geology and origin of the oil, and the prospecting. Map. 300 w. Eng & Min Jour—Dec. 14, 1901. No. 44949.

Rare Metals.

The Analysis, Detection, and Commercial Value of the Rare Metals. J. Ohly. Information for the purpose of facilitating researches, and indicating the more reliable methods of distinguishing and analyzing the minerals containing rare metals. 500 w. Min Rept—Dec. 5, 1901. Serial. 1st part. No. 44842.

Salt Works.

The Salt Works of Austria in 1898 and 1899 (Die Salinen Oesterreichs in den Jahren 1898 and 1899). Abstract of the official government reports. Serial. Part I. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 30, 1901. No. 45181 B.

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Tasmania.

Tin Mining at St. Helens (T.). George A. Waller. Describes the deposits and the various workings. 4000 w. Aust Min Stand—Oct. 17, 24, 31, 1901. Serial. 3 parts. No. 44728 each B.

Zinc.

Aluminum-Zinc Alloys. Dr. Joseph W. Richards. Gives results of experiments made with these alloys and the proportions that give valuable results. 1000 w. Eng & Min Jour—Nov. 30, 1901. No. 44,762.

The Removal of Iron from Zinc Blende. Dr. William B. Phillips. Information concerning experiments made with a view of separating the iron-bearing compounds from the blende. 1800 w. Eng & Min Jour—Nov. 30, 1901. No. 44761.

RAILWAYS AND TRAMWAYS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in October. A condensed record of the principal accidents. 3500 w. R R Gaz—Nov. 29, 1901. No. 44670.

Train Accidents in the United States in November. Record of the principal accidents, with remarks on those of special interest. 4500 w. R R Gaz—Dec. 20, 1901. No. 44991.

Electricity vs. Steam.

The Electrification of Our Railways. Philip Dawson. Discusses this subject, especially the problem as related to suburban traffic. 2200. Elec Rev, Lond—Dec. 13, 1901. 45030 A.

Management.

Engineers and Railway Management (Eisenbahnbetrieb und Ingenieur). G. Gerstel. A review of the relation of the work of the engineer to the general details of railway operation and management. 7500 w. Zietschr d Oesterr Ing u Arch Ver—Nov. 29, 1901. No. 45170 B.

Siberian Railway.

From Pekin to St. Petersburg by Rail. Alfred Stead. An interesting account of a journey via Manchuria and Siberia to London; from Japan. 1800 w. Rev of Revs—Dec., 1901. No. 44703 C.

Trains.

Standard Trains. Discusses the increased weight of locomotives and rolling stock, and of axle loads the composition of trains, etc. 2500 w. Engr. Lond—Nov. 22, 1901. No. 44742 A.

Train Staff.

The Train Staff on the Reading. Brief illustrated description of the electric train staff introduced in a short section of single track line between Mahanoy tunnel and Buck Mountain. 1000 w. R R Gaz—Dec. 6, 1901. No. 44803.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Maintenance. C. H. Quereau. Discusses the importance of having reports and a check inspection, suggesting a method. 1700 w. Ry & Engng Rev—Nov. 30, 1901. No. 44700.

I. Some Problems in Maintenance Arising from Rapid Increase in Air-Brake Equipment. E. M. Herr. II. What Shall Be Done to Maintain the Air-Brake Equipment on Our Freight Cars? T. W. Demarest. Two papers discussed together. 1300 w. W Ry Club—Nov., 1901. No. 44961 C.

Cars.

Large Railway Wagons. Illustrated description of fine cars built in England. 1700 w. Engng—Nov. 29, 1901. No. 44,852 A.

New 80,000 lbs. Capacity Box Cars for the Chicago, Burlington & Quincy Railroad. Drawings and description. 600 w. R R Gaz—Dec. 6, 1901. No. 44802.

The Increase in Capacity of Open Freight Wagons (Ueber die Erhöhung der Lade für Lingket der Offensen Güterwagen). H. von Schwabe. A discussion of the advantages of large coal cars, considering especially the Prussian railways. 5000 w. Glückauf—Nov. 30, 1901. No. 45183 B.

The Pennsylvania 100,000 Lbs. Capacity Box Cars. Illustrations from working drawings, with brief description. 700 w. Ry & Engng Rev—Dec. 7, 1901. No. 44,874.

Combustion.

Locomotive Combustion. J. W. Shepherd. Considers processes involved in locomotive combustion without entering into details of application. Also discussion 4300 w. W Ry Club—Nov., 1901. No. 44962 C.

Draft-Gear.

The Master Car Builders' Draft Gear Tests. A copy of the plan of draft rigging tests agreed upon. Ill. 1300 w. R R Gaz—Dec. 13, 1901. No. 44899.

The Sessions-Standard Friction Draft Gear—Type C. Illustrations with records of laboratory and drop tests. 2000 w. R R Gaz—Nov. 29, 1901. No. 44666.

Economy.

Economy in Locomotive Service. G. R. Henderson. Discusses economies regarding this service, and the various functions

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pertaining to it. The present article is devoted mainly to fuel and the practices affecting it. 3500 w. R R Gaz—Dec. 6, 1901. Serial. 1st part. No. 44799.

Economy in Plant for Traction Stations. Discusses methods of determining the most economical design. 1800 w. Elec Rev, Lond—Dec. 13, 1901. No. 45031 A.

Electric Locomotives.

Electric Locomotives and Motor Cars at the Exposition of 1900 (Les Locomotives et les Automotrices Electriques à l'Exposition de 1900). R. Godfernaux. Describing and illustrating some recent applications of electric traction to main-line service. 5000 w. Rev Gen des Chem de Fer—Nov., 1901. No. 45143 H.

Electric Locomotives for Shops. Illustrates and describes a storage battery electric locomotive, well adapted to the work for which it was designed. 900 w. R R Gaz—Dec. 20, 1901. No. 44990.

The Electric Locomotives of the Orleans Railway (Die Elektrischen Lokomotiven der Orléans-Bahn). H. Pforr. Full detailed description of the heavy electric locomotives, hauling trains from the Austerlitz to the Quai d'Orsay stations in Paris. 2500 w. 2 plates. Glasers Annalen—Nov. 15, 1901. No. 45171 D.

Electric Traction.

Tangential Traction. Translation of an article from the *Madrid Mining Review* on a system of electric traction. 1100 w. U S Cons Repts, No. 1214—Dec. 14, 1901. No. 44878 D.

The Wannsee-Berlin Electric Railway. Illustrates and describes a line that has been in operation since August, 1900, and that is equipped for heavy traffic. It is mainly used as a steam-locomotive line, running an electric train. 2800 w. Engr, Lond—Dec. 6, 1901. No. 44921 A.

Fuel Economy.

Methods of Reducing Fuel Consumption in Locomotives (Massanahmen zur Herabminderung des Kohlenverbrauchs im Lokomotivenbetrieb). H. Glasenapp. A description of the method of using the exhaust from the air-brake pump to heat the feed-water as practised in America. 1500 w. Tram & Ry Wld—Nov. 14, 1901. No. 45172 D.

Greenock.

The Tramways of Greenock, Port Glasgow, and Gourock. An illustrated article describing the line and its equipment. 3000 w. Tram & Ry Wld—Nov 14, 1901. No. 44750 B.

Interurban.

The Milan-Monza Interurban Tramway. Guido Semenza. Brief illustrated description of a road using the overhead system. 1200 w. St. Ry Jour—Dec. 7, 1901. No. 44833 D.

The New Bedford & Onset Street Railway. Illustrated description of a recently opened interurban line, with information concerning it. 2500 w. St. Ry Rev—Dec. 15, 1901. No. 45012 C.

Italy.

Electrical Tramways and Railways in Italy. Magrini Effren. Reviews the great development of electrically worked lines. 2200 w. Tram & Ry Wld—Nov. 14, 1901. No. 44751 B.

Locomotives.

Baldwin-Vanderbilt Ten-Wheel Passenger Locomotives—Atchison, Topeka & Santa Fe. Illustrates details of oil-burning 10-wheel passenger locomotives recently delivered. 600 w. R R Gaz—Nov. 29, 1901. No. 44669.

Brooks Chautauqua Type Passenger Locomotive, B., R. & P. Ry. Illustrated description of recently built engines using bituminous coal. 900 w. Ry & Engng Rev—Dec. 7, 1901. No. 44875.

Compound Freight Locomotive by the Vulcan Company (Locomotive Compound à Marchandises Construirte par la Société Vulcan). F. Barbier. Illustrated description of eight-wheel engine exhibited at Paris, 1900. 1200 w. 1 plate. Génie Civil—Nov. 23, 1901. No. 45100 D.

Compound Goods Locomotive of the Vulcan Company. Illustrations with detailed description of four-coupled goods engine for the Prussian State Railways. 800 w. Engng—Dec 6, 1901. 44929 A.

Consolidation Locomotive for the Mexican Central. Illustrated detailed description of large engine designed by F. W. Johnstone. 2200 w. Ry Age—Nov. 29, 1901. No. 44702.

Eight Wheels Coupled Coal Locomotive. Drawing and description of the latest type of mineral engine built for the North-Eastern Ry Co. of England, with an account of the work done by this class. 1200 w. Engr, Lond—Nov. 29, 1901. No. 44861 A.

Frames, Cylinders and Saddles—Pennsylvania Class E—2 Locomotives. Illustrates and describes changes made in the development of this class of engine. 800 w. R R Gaz—Dec. 13, 1901. No. 44900.

Locomotives at the Exposition of 1900 (Les Locomotives à l'Exposition de 1900). F. Barbier. Describing and illustrating the American and the French engines exhibited at Vincennes. 8000 w. 2 plates. Rev Gen de Chem de Fer—Dec., 1901. No. 45,146 H.

Mogul Freight Locomotives for the Southern Pacific. Illustrations, dimensions, and brief description. 600 w. R R Gaz—Nov 29, 1901. No. 44667.

Prairie Type Passenger Locomotives. Illustrated description of one of the forty-five large engines being built for the A. T. & S. F. Ry for working passenger trains over the 16-degree curves and grades of

We supply copies of these articles. See page 811.

184-ft. per mile. 600 w. Am Engr & R R Jour—Dec., 1901. No. 44688 C.

Recent Locomotive Construction and Performance. F. J. Cole. An illustrated paper, with a lengthy discussion introduced by S. W. Vauclain. 20300 w. N Y R R Club—Nov. 21, 1901. No. 44963.

The Player-Baldwin Oil-Burning Consolidation Locomotives. General views and details of the design of Mr. John Player, with description and editorial. 2300 w. R R Gaz—Dec. 20, 1901. No. 44988.

Unsymmetrical Movement of Locomotives. Gives the contribution of Mr. Herdner to the discussion of Baron Joseph Engerth's report to the International Ry. Cong. concerning experimental investigations made. 2800 w. R R Gaz—Dec. 6, 1901. No. 44801.

Von Borries Four-Cylinder Compound Locomotive. From *Le Genie Civil.* An illustrated description of an example of the best practice in compound locomotive work abroad. 1200 w. Ry Age—Dec. 20, 1901. No. 45021.

Locomotive Tests.

Comparative Locomotive Tests. A record of locomotive tests on the Mich. Cent. Ry., undertaken to determine the policy of building heavier engines, and to ascertain the extent of their advantages, combined with wide fire-boxes and compounding. 2500 w. Am Engr & R R Jour—Dec., 1901. No. 44690 C.

Trials of the Compound Locomotives of the Western Railway of France (Essais Comparatifs avec les Machines Compound de la Compagnie de l'Ouest). E. Decourt. Full data and results of important trials of four-cylinder compound French and Italian locomotives. 10000 w. 5 plates. Rev Gen des Chem de Fer—Nov., 1901. No. 45142 H.

New England.

The System of the Milford, Holliston and Framingham Street Railway Company. An illustrated description of an interurban electric railway of interest. 2800 w. St Ry Jour—Dec. 7, 1901. No. 44831 D.

Oil Fuel.

Oil Fuel for Locomotives. H. B. Gregg. The present article gives an illustrated description of the essential equipment for the successful burning of crude oil in locomotives, and the operating of oil burners. 2500 w. Am Engr & R R Jour—Dec., 1901. Serial. 1st part. No. 44691 C.

Operation.

Notable Features in the Operation of the Union Traction Company of Indiana. An illustrated article describing interesting features of an extensive interurban line. 3200 w. St Ry Jour—Dec. 7, 1901. No. 44837 D.

Platforms.

Street Car Platforms. W. E. Partridge. An illustrated review of the various types and the mechanical appliances with which it is equipped. 2800 w. St Ry Jour—Dec. 7, 1901. No. 44836 D.

Resistance.

Train Resistance. J. A. F. Aspinall. Abstract of a paper read before the Inst. of Civ. Engrs. dealing with results of experiments carried out with a dynamometer car on the Lancashire and Yorkshire Railway, in an endeavor to arrive at the tractive effort required to haul modern railway carriages. Also editorial. 2000 w. Engr, Lond—Nov. 29, 1901. No. 44898 A.

Rolling Stock.

Tramway Rolling Stock at the Exposition of 1900 (Le Matériel Roulant des Tramways à l'Exposition de 1900). R. Godfernaux. A general review of the equipment for electric tramways as shown at Paris in 1900. 9000 w. 4 plates. Rev Gen de Chem de Fer—Dec., 1901. No. 45147 H.

Stray Currents.

Electrolysis of Underground Metallic Structures. L. C. Anderson. Explains the conditions accompanying gas or waterworks piping systems and the methods of construction and operation of single trolley electric railroads, showing the effect and discussing the remedy. 4600 w. Fire & Water—Dec. 21, 1901. No. 45068.

Switzerland.

The Electric Tramway of St. Moritz, Switzerland. Brief illustrated description of an interesting installation. 700 w. Elec Rev, N. Y.—Dec. 14, 1901. No. 44956.

Trolleys.

A plea for the Bow Trolley. E. Kilburn Scott. Considers the advantages and disadvantages of collecting current by means of a bow contact and by means of a wheel. 800 w. Elec Engr, Lond—Nov. 22, 1901. No. 44720 A.

Control of Overhead Trolley Wire by Circuit Breakers in Feeder Boxes. Presenting the advantage of having the circuit breakers in the boxes. 500 w. Elec Engr, Lond—Nov. 22, 1901. No. 44722 A.

Underground.

Shallow Underground Tramways. C. H. Wordingham. Reviews the report of Messrs. Baker and Rider, presented to the London County Council. 2600 w. Elec Rev, Lond—Dec. 13, 1901. No. 45032 A.

Water-Scoops.

Experiments with Track Tank Scoops. Gives results of some experiments made last year on the N. Y. C. & H. R. R. 900 w. Am Engr & R R Jour—Dec., 1901. No. 44692 C.

We supply copies of these articles. See page 811.

Theory of Locomotive Water-Scoops. I. P. Church. Explanation of case with open trough, and case with closed pipe. 1400 w. Am Engr & R R Jour—Dec., 1901. No. 44689 C.

Wigan.

Wigan System Corporation Electric Tramways. Illustrated detailed description of the present system which will probably be extended. 2700 w. Tram & Ry Wld.—Nov. 14, 1901. No. 44749 B.

NEW PROJECTS.

Bagdad Railway.

The Bagdad Railway Project. Information relating to the line under construction by German capitalists, and the proposed branches. Ill. and map. 1200 w. Rev of Revs—Dec., 1901. No. 44704 C.

Extension.

The Islington Extension of the City and South London Railway. A description of this recently opened section, and its equipment. Ill. 1700 w. Transport—Nov. 22, 1901. No. 44708 A.

The Pennsylvania and Long Island R. R. Extensions Across the North and East Rivers. Gives a map showing the projected tunnels and bridges across the North and East Rivers, and discusses the work. 1700 w. Eng News—Dec. 19, 1901. No. 44984.

High-Speed.

High-Speed Electrical Traction in Germany. A description of the apparatus built for the high-speed traction experiments on the Berlin-Zossen military railway, with critical remarks concerning its adaptation to the use for which it is intended. 4200 w. Elec Rev, N. Y.—Nov. 30, 1901. No. 44672.

The Proposed New York and Portchester Railway. Particulars of the plans and extracts from the testimony given to prove the convenience and necessity of the road. 10500 w. St Ry Jour—Dec. 7, 1901. No. 44838 D.

London Underground.

New Underground Electric Railroads for London. Discusses proposed plans for relieving the congested traffic of the streets. 1700 w. Sci Am—Nov. 30, 1901. No. 44650.

The Electrification of the London Underground Railway (Die Elektrisirung der Londoner Untergrundbahn). An editorial discussing the relative merits of the continuous and polyphase systems of electric traction for the London Underground Railway. 2500 w. Elektrotech Zeitschr—Nov. 28, 1901. No. 45195 B.

Mountain Railways.

Difficult Mountain Railway Construction in Switzerland. Contour maps and description of new lines under construction, especially the line connecting Thusis with St. Moritz, involving a number of compound loops, mostly in tunnel, with numerous tunnels, bridges, etc. 1700 w. Eng News—Dec. 19, 1901. No. 44987.

Russia.

Railroads in Russia. Interesting information of the roads furnishing direct connection between St. Petersburg and Port Arthur. 1300 w. U S Cons Repts, No. 1213—Dec. 3, 1901. No. 44863 D.

Switzerland.

New Railway Projects in Switzerland (Neue Schweizerische Eisenbahn projekte). Robert Moses. Discussing matters of costs and concessions for new railways in Switzerland. 2000 w. Schweizerische Bauzeitung—Dec. 7, 1901. No. 45177 B.

The Montreux—Bemese Oberland Railway (Die Montreux—Bemer Oberland-Bahn). An account of the new electric road to run between Montreux to Lake Thun, through the Bemese Oberland. 3000 w. Maps. Schweizerische Bauzeitung—Nov. 23, 1901. No. 45176 B.

PERMANENT WAY AND FIXTURES.

Car-Transfer.

Standard Car-Transfer Bridge; N. Y. Central & Hudson River R. R. Illustrated description. 900 w. Eng News—Dec. 19, 1901. No. 44982.

Bonding.

Rail Bonding. W. A. Neff. On the importance of proper rail bonding, calling attention to some points often neglected. 1200 w. Tram & Ry Wld—Nov. 14, 1901. No. 44752 B.

Grade Crossings.

A Grade Crossing Removed at Harrisburg, Pa. An illustrated description of the work of eliminating the Market street grade crossing. 500 w. Ry Age—Dec. 6, 1901. No. 44827.

The Abolition of Grade Crossings on the Providence Division of the New York, New Haven & Hartford Railroad, Between Boston and Dedham. Arthur S. Tuttle. A statement of the conditions and requirements of the decree of the court, with illustrated description of the construction. 9400 w. Jour Assn of Engng Soc's—Nov., 1901. No. 45074 C.

Rail Joint.

An Improved Rail Joint (Nouveau Joint pour Rails). An illustrated description of the Scheinig and Hofmann system, extensively used in Austria-Hungary. 1000 w. Revue Technique—Nov. 10, 1901. No. 45111 D.

Railway Curves.

The Field Practice of Relining Railway

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Curves. Howard C. Ives. Considers the cases under three heads, giving methods used by writer. 1500 w. Eng News—Dec. 26, 1901. No. 45056.

Repair Shops.

Extensive Repair Shops at Kansas City. Illustrated description of the repair shops of the Metropolitan St. Ry Co. of Kansas City now in progress of construction. 1200 w. St Ry Jour—Dec. 7, 1901. No. 44-834 D.

Round House.

The Round House of the Pittsburg & Lake Erie R. R. Brief illustrated description of the structure at McKee's Rocks, Penn. 700 w. Ry Mas Mech—Dec., 1901. No. 44764.

Station.

Concrete Passenger Station for the Northern Pacific Ry., at Bismarck, N. D. Illustrated description. 1200 w. Ry & Engng Rev—Dec. 21, 1901. No. 45006.

New Station for the Southern at Knoxville, Tenn. Brief illustrated description of a fine station now in process of construction. 500 w. Ry Age—Dec. 6, 1901. No. 44826.

Terminal.

Port Richmond Terminal of Philadelphia and Reading Ry. Illustrates and describes what is supposed to be the largest seaboard railroad terminus in the United States, if not in the world. Covers 140 acres of ground and contains 73 miles of track. 1500 w. Ry & Engng Rev—Dec. 14, 1901. No. 44942.

The Long Island Railroad Entrance to Manhattan. Illustrates the proposed terminal at Thirty-third St., near Broadway, giving information concerning the plans. 500 w. R R Gaz—Dec. 6, 1901. No. 44800.

Track Construction.

Street Railway Track Construction at Scranton, Pa. Illustrated description of a substantial system comprising a concrete base, T rails, steel ties and reinforced joints, with brick and asphalt paving. 2000 w. Eng News—Dec. 26, 1901. No. 45060.

The Track Construction Department of the Union Traction Company, Philadelphia. Illustrated description of track apparatus and tools used by this company. 2500 w. St Ry Jour—Dec. 7, 1901. No. 44832 D.

Tunnels.

See Civil Engineering, Construction.

Yards.

Yards for Sorting Freight Terminal Classification. Presents plans of division and terminal yards, discussing the requirements. 2200 w. R R Gaz—Dec. 20, 1901. No. 44989.

TRAFFIC.

Freight.

The Decline in Freight Car Performance. Reviews the efforts being made by J. W. Midgley to get the roads to agree upon a per diem charge for the use and detention of cars. 3300 w. Ry Age—Dec. 13, 1901. No. 44944.

London.

Electric Railway Communication Within the Metropolis. Editorial discussion of the schemes and the modifications introduced. 3000 w. Engng—Nov. 29, 1901. No. 44-854 A.

Passenger Service.

Special Local Passenger Service on a Steam Railway to Compete with an Interurban Electric Road. Illustrates a special car built for the Dayton & Union R. R. describing its equipment. 500 w. Eng News—Dec. 5, 1901. No. 44796.

Rates.

Preferential Rates. A letter from Walker D. Hines, objecting to statements recently published in this paper. Also editorial. 2300 w. Ry Age—Dec. 20, 1901. No. 45020.

Tonnage.

The Train Tonnage Craze. G. W. Turner. Unfavorable to heavy tonnage trains. Discusses the subject. 1600 w. Ry & Engng Rev—Dec. 14, 1901. No. 44943.

MISCELLANY.

Accumulators.

Accumulators and Electric Traction Systems. Discusses the use of storage batteries especially as related to present conditions in England. 2200 w. Elec Rev, Lond—Dec. 13, 1901. No. 45033 A.

Interurban.

The Relation of Interurban Roads to City Roads. Ira A. McCormack. Read before the American St. Ry. Assn. Discusses traffic agreements, rails, cars, and various matters, giving the agreements of various cities in the United States. 6600 w. St Ry Jour—Oct. 12, 1901. No. 43-729 D.

Operation.

The Public, the Operator, and the Company. C. S. Sergeant. Read before the American St. Ry. Assn. Considers some points in the relations of street railways to the public. 2800 w. St Ry Jour—Oct. 12, 1901. No. 43727 D.

Russia.

Russia's Oldest Main Railroad. An account of the Nicolas line, which has just passed its fiftieth anniversary. 1300 w. Engr, Lond—Dec. 6, 1901. No. 44922 A.

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EXPLANATORY NOTE.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.

Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Metallurgy. *s-m.* New York.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Klijk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

IMPROVED MACHINERY

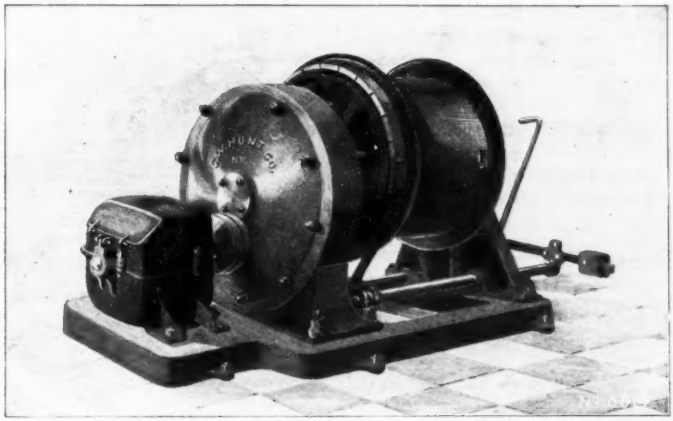
New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Electric Hoists.

ON account of the constantly increasing use of electric hoists, the following brief illustrated description of those manufactured by the C. W. Hunt Company, of West New Brighton, New York, may be of interest.

The three essential parts of these hoists are the rope drum, the gearing and the electric motor. Each of these parts is made in a series of sizes. By a suitable combination of these parts a hoist of any desired capacity and speed, within the limits of modern practice, may be built.



There are four factors that materially affect the size and cost of the hoist—namely, the load, the speed, the height to which the load is hoisted and the frequency of the trips. These factors affect the size, operation and cost in the following manner: If the load is increased, the size, weight and strength of the mechanism will be increased—that is, a larger size must be used; if the velocity of hoisting is increased, the size and power of the motor will be increased, the other parts remaining the same; if the height to which the load is hoisted is increased, the drum must be increased to hold a longer rope, the motor remaining the same; if the frequency of the trips is increased, the size of the motor will be increased, the other parts remaining the same.

There are three methods of operating electric hoists: (1) Running the motor continuously, hoisting the load by throwing in a friction clutch and lowering by a band brake. This method is suitable either for alternating or direct current motors. (2) Starting and stopping the motor for each lift, lowering by a band brake. This is better suited for direct current than alternating motors. (3) Running the motor forward to hoist and backward to lower. A direct current motor with reversing switches is used for this work.

The mechanism of the hoist is so arranged

that any size or make of motor may be used. The motor is connected to the hoist by a flexible coupling.

The great flexibility of electric transmission allows hoists to be installed to advantage in many situations where it is difficult or inexpedient to use steam driven machinery. One of the great advantages is that the expense for power begins only when the hoist is started, and entirely ceases when the motor is stopped.

The friction clutch for use on an electric hoist has far different work from one used for starting shafting, which is thrown in once or twice only, each day.

The rope drums used in the Hunt Company's hoist vary in diameter from 12 inches to 60 inches. The drum barrel is sheet steel with cast iron flanges on each end. A suitable fastening is provided to secure the rope and a hole is arranged in the drum, through which the surplus rope is passed and coiled on the interior of the drum.

The necessary slipping of the friction surface generates heat that must be rapidly dissipated or the friction surfaces would soon be destroyed. This is accomplished in these drums by making the spokes in the form of propeller blades, so that whenever the drum revolves in hoisting or lowering, they force a current of air over the heated surfaces. The part of the friction generating the heat is arranged to lie directly in the path of this current of air. A remarkable difference has been noticed in rapid work between a friction clutch with this cooling device and the ordinary arrangement.

One of the difficulties in applying electricity to hoisting machinery is the necessary reduction from the high rotative speed of the motor armature to the comparatively slow speed of the winding drum.

With these hoists, machine cut spur tooth gears are employed. They are hydraulically pressed on shafts that are ground true on dead centers. The gears are completely enclosed in an oil tight and dust proof iron case, which forms a reservoir for a bath of oil in which the gears run.

Powerful band brakes are applied to the end of the drum opposite to the friction clutch so that the heat generated in one may not affect the accurate working of the other.

The remarkable convenience of electric hoists has been found to be an important element in their favor. They are always ready for service, by simply switching on the electric current for driving the hoist.

There has been such a demand for these hoists that the Hunt Company now find it necessary to carry them in stock, nearly finished, so that it is only necessary for them to assemble the parts that are required in order to make the combination suited for a particular plant.

Direct Connected Electric Exhauster.

THE accompanying illustration shows one of the many interesting adaptations of electric apparatus so common in these days. It consists of a centrifugal fan or exhaust blower driven by a direct connected motor, for which service, by reason of the identity of motion of the driving and driven elements of the combination, the electric motor is peculiarly adapted. The constant resistance to the rotation of the fan wheel is overcome by a constant torque acting on the armature.

The fan may be designated as a right hand bottom horizontal discharge exhauster and is composed of a rotating blast wheel and a stationary casing. This casing consists of a circular discharge mouth piece cast integral with the circumferential rim, to which is bolted the two side plates. In the plate nearer the motor is provided the opening for the motor shaft, while in the other is located the circular air inlet. A distinction

is usually made between blowers and exhausters, the latter having but one inlet, and former having one on either side.

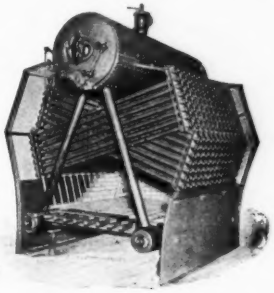
The blast wheel is built up of steel plate blades with backwardly curved tips, bolted to spider arms carried on a cast iron hub. The dimensions of these blades, as well as of the inlet and discharge openings, have been proportioned, after careful experimenting, so as to afford maximum efficiency. The air enters the fan in a direction parallel to the shaft, passes outward along the blades with an increasing acceleration due to the centrifugal force, and is discharged radially from the tips with a velocity substantially equal to the peripheral velocity of the wheel. The pressure developed by a given fan varies as the cube thereof. The volume delivered is approximately proportional to the number of revolutions. Hence the loss entailed by using too small a fan and speeding it up to secure a given output is entirely obvious.

The motive power of the fan shown herewith is a motor manufactured by the General Electric Company. A cast iron bed supports both motor and blower, affording a rigid construction with no possibility of an alteration of alignment. The fan itself is a product of the works of the Buffalo Forge Company, of Buffalo, N. Y., though it will be understood, of course, that the details of construction may be such as to allow the attachment of any standard motor. These fans are constructed by the Buffalo Forge Company in sizes up to No. 11 B, which requires 50 horse power, when developing 6 ounces pressure at 1,100 revolutions per minute.

Worthington Water-Tube Boiler.

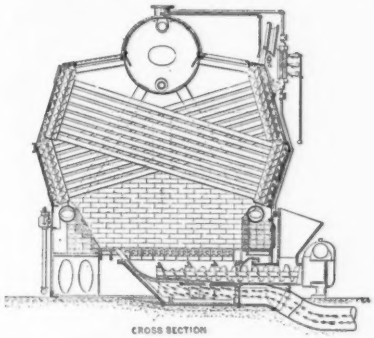
OF particular interest at the present time, due to its being installed in many of the prominent fortifications of the U. S. Government along this coast, is the Worthington water-tube boiler, which since the Spanish-American War, has formed an important part of the following prominent fortifications: Forts Wadsworth, Hancock, Hamilton, Totten, Schulyer and Newton in New York harbor; and Forts Adams and Greble at Newport.

The following features of this boiler are worthy of special attention: (1) It is sectional, so arranged (see illustration) that the individual headers coming together completely enclose the fire-box, even without the assistance of the iron outer casing. The outside casing, a system of doors, is lined with non-conducting material which reduces radiation to a minimum. These doors make every part of the interior accessible for



cleaning and examination. The grate surface of liberal dimensions extends under the entire heating surface, and, in consequence, this is all subjected to active and efficient work. Due to the liberal grate surface, this boiler may be forced much beyond its rated capacity, if so desired, and even under these conditions, the perfect system of circula-

THE WORTHINGTON WATER-TUBE BOILER
WITH THE
AMERICAN STOKER ATTACHED



CROSS SECTION

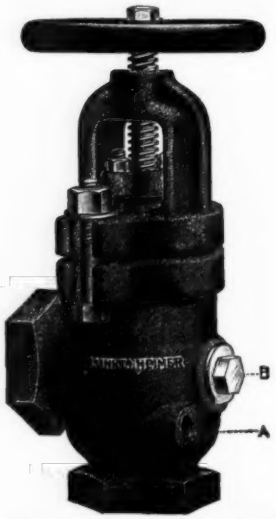
tion—each section distributing its steam and water into the steam drum along its entire length—utilizes the complete area for effective disengaging surface, and, discharging approximately at the water level, dry steam is ensured. Short and straight tubes are used, thus assuring minimum expansion. All tubes are expanded into ground joints. Large power can be placed in small space,

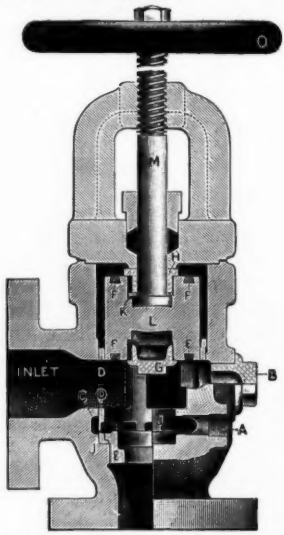
and due to the sectional features a boiler of 200 horse power may be readily delivered into a building through a 4 x 4 feet opening. No brick-work is used as an enclosing medium; no bent tubes are used in any part of the structure; no screwed joints; no gaskets; all joints are metal to metal. These boilers are built in units from 20 to 360 horse power and are adapted for either hand firing or mechanical stoking. The first view shows the 2½" tube type of boiler, 7' length of tube, built in units up to 125 horse power. Above this size the side-fired type is used as shown in the second view. This type is built from 125 horse power up to 360 horse power. Many hundreds of these boilers are in operation in the most prominent office buildings and installations throughout the country.

Correspondence is requested with those who may be in the market for boilers. The further merits will be explained by the manufacturers to parties interested. Address New York Safety Steam Power Co., New York.

The "Duro" Blow-Off Valve.

BLOW-OFF valves have probably given more trouble than any of the other fittings which are part of boiler equipment. Many kinds have been offered upon the market which are claimed to possess the chief requisite in valves of this kind, *i. e.*, durability; but, in service, they all appear to lack this essential feature.





Referring to the illustrations herewith it will be seen that the general form of this new valve is quite similar to the iron body angle blow-off valve which has been so extensively used for some years past. The object of this improved valve is to include whatever merits the old-style valve possessed, an', in addition, a distinctive feature, the novelty of which will at once impress users of its practicability. Heretofore in all makes of blow-off valves the seat was so located that as the disc approached same there would be an accumulation of scale and sediment. The effect of this accumulation would be to cut out the bearing surfaces to such an extent that in a short time the valve would become leaky. Various methods have been invented whereby the disc would fit tightly in the valve body, the object being to prevent the scale from passing on to the seat bearing after the disc had passed and cut off the inlet. This method, however, has not proven satisfactory, as the valve body would soon wear, and, in a short time, permit the passage of scale and sediment. In the "Duro" valve these defects have been overcome. The plug fits snugly in a separate and easily-removable bronze casing, which can be readily replaced when

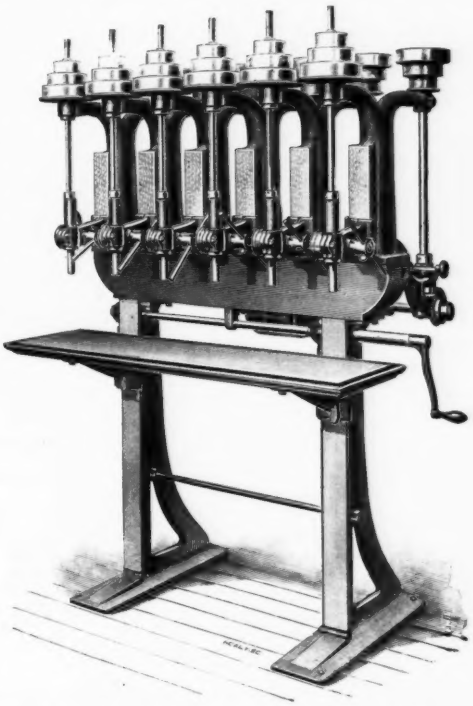
worn. Any accumulation of scale on the seat is prevented by a jet of steam blowing over same.

Referring to the illustrations it will be noticed that there is a steam inlet (*a*), and, on the sectional cut, it will be seen that this connects with an annular passage (*c*). The iron body of the valve has a brass casing (*d*) with circular slot (*j*) cut into the side of same just below the level of the seat (*e*). This casing (*d*) is held in place in the valve body by the seat ring (*e*) screwing over same, both of which are removable at any time for repairs or replacement with new parts. The opening (*a*) is connected to the steam part of the boiler and a suitable valve interposed. The object of this steam inlet (*a*) is to admit steam to *c* and *j*, and discharging from the latter blows across the seat, which will clean off any scale or sediment that may have accumulated on it, so that the disc and seat bearing, when in contact, will be perfectly clean. All parts about the valve are very heavily and substantially constructed. Fuller details may be had from the manufacturers, the Lunkenheimer Co., Cincinnati, Ohio.

A New Multiple-Spindle Drill.

THIS drill is so simple that hardly a word is needed to explain it. It is also a self-contained drill. No countershaft is needed or included. It belts direct from the main line.

About all multiple-spindle drills need two belts for each spindle, and one of those is a quarter-twist, which is a very bad thing on a short belt. With this drill only one belt for each spindle is needed, and that a straight open belt. On a six or eight-spindle drill this means a considerable saving in the first cost of belts and a great saving in maintenance. This desirable feature is obtained by a pair of bevel gears, one of which is a fiber gear, so there is no noise from the gears. These gears drive the upright shafts with the cone pulleys on top, then a 1½" belt drives the spindles. The tension of the belt is never on the spindle. The quill has steel rack and pinion. The spindle is made of the best crucible steel, and is reamed with Morse taper, No. 1. The spindles are counterbalanced with a coil spring, which can be adjusted to any degree of sensitiveness. The spindles are 8" apart, and have an adjustment on the slide of 12". Spindles have stop-collars. The table has screw elevation which is operated by the crank at the right, shown in the cut. The screw is No. 3. The table brackets are fitted to the slides in front of the upright columns and a binder-screw will clamp them up tight. On an 8 or 10-



spindle drill three of these columns will support the table.

It will be seen at once that most any number of spindles can be put on a machine of this kind; all that is needed is a longer table and bridge casting; this bridge casting can be used as an oil tank and will hold an abundance of oil.

Manufactured by The George Burnham Company, Worcester, Mass.

Electric Industrial Railway.

INDUSTRIAL railways have long been recognized as a great help in many industries, as for instance, in and around manufacturing plants and mines, for contractors' purposes, and for all general purposes, and for all general uses for which a railroad could be used to advantage. Electric power is now-a-days easily to be had in most cases as there is hardly a business enterprise without an electrical equipment and the surplus electric power can be used with little or no additional expense, instead of animal or steam power. Great attention has been given to the system of building electric railways for industrial purposes by the manufacturers of railroad materials. Among the firms that have realized very good results in equipping this kind of roads, as well as running them economically, is the well known firm of Arthur Koppel, New York. This house has built many electric roads for industrial purposes as well as developing portable electric railroads.

The Arthur Koppel portable electric railway can be laid down and completely equipped within just as short a time as portable railways generally can be. All the parts composing this equipment are light and easily handled. Every detail is worked out so that there is no difficulty, and even specially constructed and patented cars for stringing the trolley wire enter into the equipment.

These electric railways have been built in many different countries, and for many different purposes, as, for instance, factory roads to bring the raw material into the plant, to carry the different materials around, and finally to take the finished product to the station, for mines, for contractors, for plantations, and even for passenger traffic.

In order to give interested parties, who are not well acquainted with this type of railroads, an opportunity to get acquainted with these industrial electric roads, their working and their equipment, the abovenamed firm has put up in their office in New York an exact model of such an electric railroad, one-tenth actual size. This road is equipped with track, overhead system, electric locomotive and many different types of cars, including coal, flat, plantation, contractors', and passenger cars.

And one who is interested in electric railroads in general is invited to call and inspect the model, and will be given all the information required.

Modern Marine Shops.

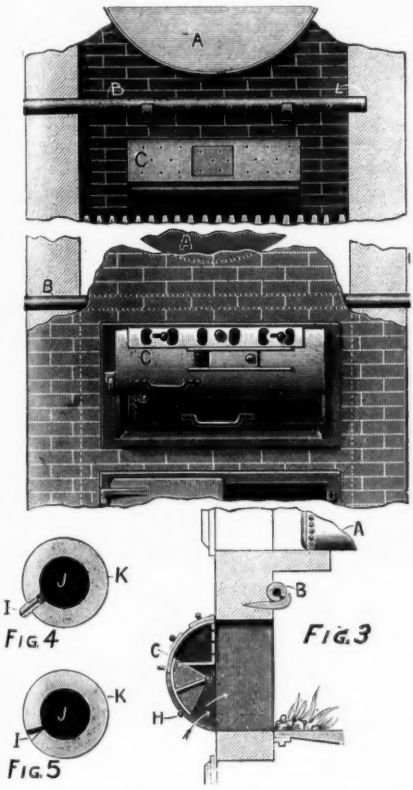
THE Marine Iron Works of Chicago, U. S. A., are entitled to praise for their energetic action in erecting new and modern buildings to replace those that were destroyed in the recent severe fire. The new buildings and equipment are greatly superior to the old and include the highest grade of modern machinery, resulting in its being the most efficient plant of its kind for building of high grade marine engines, boilers, launches, tugboats and dredges that it is possible to produce. The disastrous fire of September 24th last completely destroyed every building of the old plant, and among other valuable matter a large amount of correspondence, many of the unanswered letters being held awaiting the completion of drawings and special details. This is a loss that cannot be replaced, for not only the original letters but also the addresses and records pertaining to them were completely destroyed.

The loss of catalogues, circular matter, engravings, photographs, etc., is now most keenly felt, and it will require considerable time and attention to replace them.

"Hydro-Carbon" Boiler Equipment.

THE "Hydro-carbon" system is designed to provide the proper admission of air over the fire at the proper temperature and is very simple, yet effective, in its construction, installation and operation. A steel door *c* (see cut) is substituted for the regular fire door of the furnace, so arranged as to admit air through a lower apron with ratchet attachment, *h*, in a thin sheet, and after heating by contact with deflecting plates is passed over the fire surface; air is also admitted at top of the door through small perforations, and a peep hole provided for observing conditions of fire without opening the door. The fire can be broken up or sliced through the lower part of the door without opening the door; as less frequent firing is required, it will be seen that the chilling of fires by opening doors frequently is prevented.

A heavy metal retort, *b* and *k*, is placed over the doors exposed to interior of the furnace, steam at 10 to 15 lbs. pressure is supplied to this retort, and is superheated and decomposed by the intense heat, and injected into the fire chamber through small openings, *i*, in the form of hydrogen gas. The combined elements not only mix up the combustible gases over the fire, but form



new combinations changing the carbonic oxide into di-oxide gases, and adding heat units, increasing temperatures of the fire-chamber, and raising perceptibly the ratio of evaporation, as well as preventing the escape of carbon unconsumed in form of smoke from the burning of bituminous coal. The condition of ash in the ash pit shows almost perfect combustion and the temperature of flue gases at the stack are very much reduced. Between 200 and 300 boilers have been equipped with this device, and many evaporation and smoke abatement tests made, showing from 10 per cent. to 30 per cent. increase in evaporation as well as the same proportion in amount of coal burned, and abatement of smoke.

Copies of tests, circulars, etc., can be had by application to the office of the Steam Boiler Equipment Company of New York, Inc.

Industrial Notes.

—The H. W. Johns Mfg. Co., of New York, and the Manville Covering Co., of Milwaukee, each company having been closely identified as handling the goods manufactured by the other, consolidated their interests January 1st. The new company, whose capital stock will be $3,000,000, will be known as the H. W. Johns-Manville Co. The officers of the new company will be: Mr. T. F. Manville, president; Mr. C. B. Manville, vice president; Mr. George W. Gladwin, vice president; Mr. F. R. Babcock, treasurer; and Mr. H. E. Manville, secretary. Mr. James G. Cannon will be chairman of the board of directors; Mr. C. R. Manville will be manager of the Western Department, and he, with Mr. C. B. Manville, will remain in Milwaukee. Mr. T. F. Manville and Mr. H. E. Manville will remove to New York. The new company is rapidly completing a plant at Milwaukee for the manufacture of carbonate of magnesia and mineral wool. When this plant is completed, the company will be prepared to furnish a most complete line of all grades of steam pipe and boiler coverings and asbestos goods of all descriptions.

—Mr. S. E. Moore, the well-known accountant, for many years auditor of the Carnegie Steel Company, has been appointed auditor of the Pressed Steel Car Company.

—The Wm. Tod Co., Youngstown, O., have shipped one 17″ and 33″ x 36″ horizontal cross-compound generator engine, direct connected to a 400 K. W. generator, to the Youngstown Iron Sheet & Tube Co.; one 32″ x 48″ Porter-Hamilton engine for the Cuyahoga Steel & Wire Co., Cuyahoga Falls, Ohio; a pair of reversing mill en-

gines, with cylinders 36" x 48" for the Inland Steel Co. at Chicago.

—Among the recent contracts for bridge work taken by the American Bridge Company, of New York, are two structures for the Wabash Railroad's entrance into Pittsburg. These bridges are both cantilevers, 1,504 ft. total length with a centre span of 812 ft. They carry two tracks and the eyebars will be the largest ever manufactured in this country, necessitating the building of special machinery. One bridge is located over the Allegheny River at Pittsburg and the other at Mingo Junction, O.

—Taking effect January 1st, the Pressed Steel Car Company made the following appointments: Geo. H. Goodell appointed chief engineer. Mr. Goodell has been assistant chief engineer for several months past. Prior to this time he was connected with the Northern Pacific Railway in the capacity of mechanical engineer, and has also had experience in various capacities on other railroads. G. E. Moore appointed auditor. Mr. Moore is an expert accountant, having been employed by both the Carnegie Steel Company and the Philadelphia Company in this capacity. C. H. Judy appointed superintendent of the McKees Rocks works. Mr. Judy was formerly in the Pennsylvania Railroad service, and has been in the employ of the Pressed Steel Car Company as assistant superintendent at McKees Rocks for some months.

—On January 1st, the Bullock Electric Manufacturing Company, of Cincinnati, and the Wagner Electric Manufacturing Company, of St. Louis, established a foreign sales department with headquarters at Cincinnati. Hereafter all foreign business for the two companies, except in Mexico and Canada, will be handled by this new department, which will be under the management of Frank G. Bolles. The work of the advance department will continue under the direction of Mr. Bolles, under whose charge it has been for the past three years.

—The Cutter Company, Philadelphia and New York, on January 1st assumed the sole management of the sales of the well-known instruments manufactured by the Keystone Electrical Instrument Company, of Philadelphia.

—Brown & Frothingham, of New York City, export sales agents for several prominent manufacturers, announce that they have opened a department for the export of machine tools, which has been placed in charge of Mr. A. M. Fisher.

—The organization of the Chicago Pneumatic Tool Company of New Jersey has been completed, and on December 31, last, took over the properties proposed—namely, the business and plants of the Chicago Pneumatic Tool Compony of Illinois, the Boyer Machine Company of Detroit, Mich., the Chisholm & Moore Crane Company of Cleveland, Ohio, the Franklin Air Compressor Company of Franklin, Pennsylvania, and the new Taite-Howard Pneumatic Tool Company, Limited, of London, England. The securities issued are $2,000,000 5 per cent. twenty-year gold bonds, and $5,000,000 of common stock, there being only one kind of stock. There remains in the treasury, unissued, $500,000 of bonds, and $2,500,000 of stock. The company starts with a working capital very largely in excess of a million dollars, of which more than 50 per cent. is in actual cash. It also starts with actual earnings by the constituent companies, before this organization, at the rate of $700,000 a year, which, after paying fixed charges and sinking fund under the mortgage, leaves 11 per cent. earnings on the stock. Mr. Duntley, the President of the company, is of the opinion that these earnings will be very largely increased as the result of the unification of these properties into one company, and that one of the great needs is accomplished—namely, getting sufficient capacity to supply the trade and take advantage of the large and increased business which is constantly offering.

—The American Bridge Company of New York has taken an order for a bridge across the Ohio River at Marietta, Ohio, made up of two 220' spans, one 1,380' cantilever span and a viaduct approach of 645'. This structure is for highway and electric railway purposes.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firm issuing them. Please mention The Engineering Magazine when you write.

Air Brake.

Exceptionally handsome, large catalogue, consisting principally of full page illustrations showing the equipment on which the brake is in use. Christensen Engineering Co., Milwaukee, Wis.

Belt Conveyors.

A highly interesting catalogue, thoroughly descriptive of belt conveying machinery. The catalogue is illustrated, showing the conveyor in actual use, in some twenty-eight different styles of work. Robins Conveying Belt Company, New York.

Blowers.

Catalogue No. 135, describing the "A. B. C." heater. A new departure in heating, specially adapted for use in large buildings. American Blower Company, Detroit, Mich.

Briquetting Press.

A neat booklet, entitled "A Triumph of Evolution," describing the evolution of the frail bricking press of six years ago to the present, modern perfected briquetting press. Full page illustrations of the machines. The Henry S. Mould Company, Pittsburg, Pa.

Chain Machinery.

Catalogue containing short, concise descriptions of all chain machinery, specializing the Edgecombe hammers, improved, with descriptions of separate parts. The Turner, Vaughn & Taylor Company, Cuyahoga Falls, O.

Concentrating Table.

Attractively printed and illustrated book, showing the Overstrom diagonal concentrating table. American Engineering Works, Chicago, Ill.

Drafting Room Furniture.

Illustrated catalogue and price list of latest improved drafting room furniture. The F. W. Emerson Manufacturing Company, Rochester, N. Y.

Drill Grinders.

Supplementary catalogue of the Worcester drill grinders, manufactured by the Washburn shops. Illustrated; new features. Complete table of size, capacity and price, with telegraph code. Worcester Polytechnic Institute, Worcester, Mass.

Exhaust Heating.

Book demonstrating the Evans-Almirall hot water system of exhaust heating. Economical. Adapted to heating of large buildings. Evans, Admirall & Co., New York.

Expanded Metal.

Large handsome catalogue demonstrating the advantages of expanded metal in the construction of foundations, piers, bridges, vaults, reservoirs sidewalks, domes, etc. New York Expanded Metal Co., New York.

Fireproofing.

Handsome catalogue, illustrated, showing simplicty of construction and durability of the "Herculean" flat arch. Cheap and absolutely fireproof houses obtained by means of terra cotta. Henry Maurer & Son, New York.

Fuel Oil Equipments.

Pamphlet descriptive of latest improved fuel oil equipments. Very cleanly; moderate price. Produces uniform heat. Many commendable qualities. The Petroleum Iron Works Co., Washington, Pa.

Gas Machines.

Catalogue describing the Tirrill's "equalizing" gas machine; practically perfect. Especially adapted for suburban sections with no lighting facilities. Tirrill Gas Machine Co., New York.

Graphite Bushings and Bearings.

Small pamphlet describing clearly system of lubricating without oil or grease. Worth investigating. The Graphite Lubricating Co., Bound Brook, N. J.

Heaters, Feed-Water.

Small, compact pamphlet demonstrating the Cochrane feed-water heaters, showing efficiency. Harrison Safety Boiler Works, Philadelphia, Pa.

Hoisting Appliances.

Catalogue No. 2 (sixth edition). Fully illustrated, and indexed; telegraphic code. Complete descriptions of mining and metallurgical machinery and appliances, pumps and conveyors, Corliss engines, boilers, etc. Allis-Chalmers Company, Chicago, Ill.

Hoisting Engines.

Catalogue No. 0117, illustrated, specializing the heavy duty engine. Clear specifications of the manner of manufacturing the more important parts. Also short sketches of other improved heavy hoisting machinery. C. W. Hunt Company, West New Brighton, N. Y.

Hydraulic Jacks.

Catalogue No. 61, illustrated, demonstrating all the jacks, with tables of size, net price and raise. Complete telegraphic code. Watson-Stillman Company, New York.

Key-Seater.

Catalogue, illustrated, treating latest type of "Giant" key-seater or splining machine. Full description. Mitts & Merrill, Saginaw, Mich.

Machine Tools.

Catalogue No. 10. Illustrated, with description of all types of machine tools, specializing a new lathe carriage turret. Also special catalogue demonstrating pattern makers' lathes. Fay & Scott, Dexter, Maine.

Metal Structures.

Handsome booklet, profusely illustrated, showing styles of work made and set up. Almost every style of steel and iron structural work. Chicago Bridge and Iron Co., Chicago, Ill.

Mining Machinery.

Complete catalogue, containing illustrations and descriptions of all types of mining machines. Indexed. Hammond Manufacturing Co Portland, Oregon.

Motors and Generators.

Catalogue No. 117, well illustrated, treating only machines and combinations of the high-speed type which are distinctly standard, with table commutations for each machine. B. F. Sturtevant Company, Boston, Mass.

Moulding Machine.

Brief, attractive folder, illustrating and thoroughly demonstrating vibrator frame moulding machines, showing dispatch and economy in operating. Very concise. Tabor Manufacturing Co., Philadelphia, Pa.

Oil Filter.

Small booklet, entitled "The White Star," demonstrating clearly the "White Star" oil filter, with sectional view illustrations showing the filter in operation, etc. Pittsburgh Gage & Supply Company, Pittsburgh, Pa.

Pulleys.

Handsomely gotten out catalogue, illustrated, treating the Chase Wood Rim pulley. Table of capacity. Chase Pulley Co., Providence, R. I.

Punching and Shearing Machinery.

Catalogue No. 20, large, fully indexed, complete telegraphic code, treating scientifically, with illustrations, all power punching and shearing machinery. The Long & Allstatter Company, Hamilton, O.

Rotary Converters.

Circulars Nos. 1,028 and 1,058, illustrated. The first discusses the advantages of the improved rotary converter, and its requisites; complete tables. The latter treats of the railway motor. Westinghouse Electric & Manufacturing Company, Pittsburg, Pa.

Steam Specialties.

Pamphlet, illustrated, tables of specifications, giving prices of all kinds of steam specialties such as safety water columns, feed-water controllers, emergency traps, etc. Wright Manufacturing Company, Detroit, Mich.

Steam Trap.

Small attractive booklet, showing the Eureka steam trap. Full description. Price list and capacity table. Eureka Iron Co., Chicago, Ill.

Screens, Ore.

Illustrated pamphlet, descriptive of the manganese steel revolving screens, with thorough description of separate parts; claims process of manufacture renders the machine practically indestructible. Taylor Iron & Steel Company, High Bridge, N. J.